OZM RESEARCH

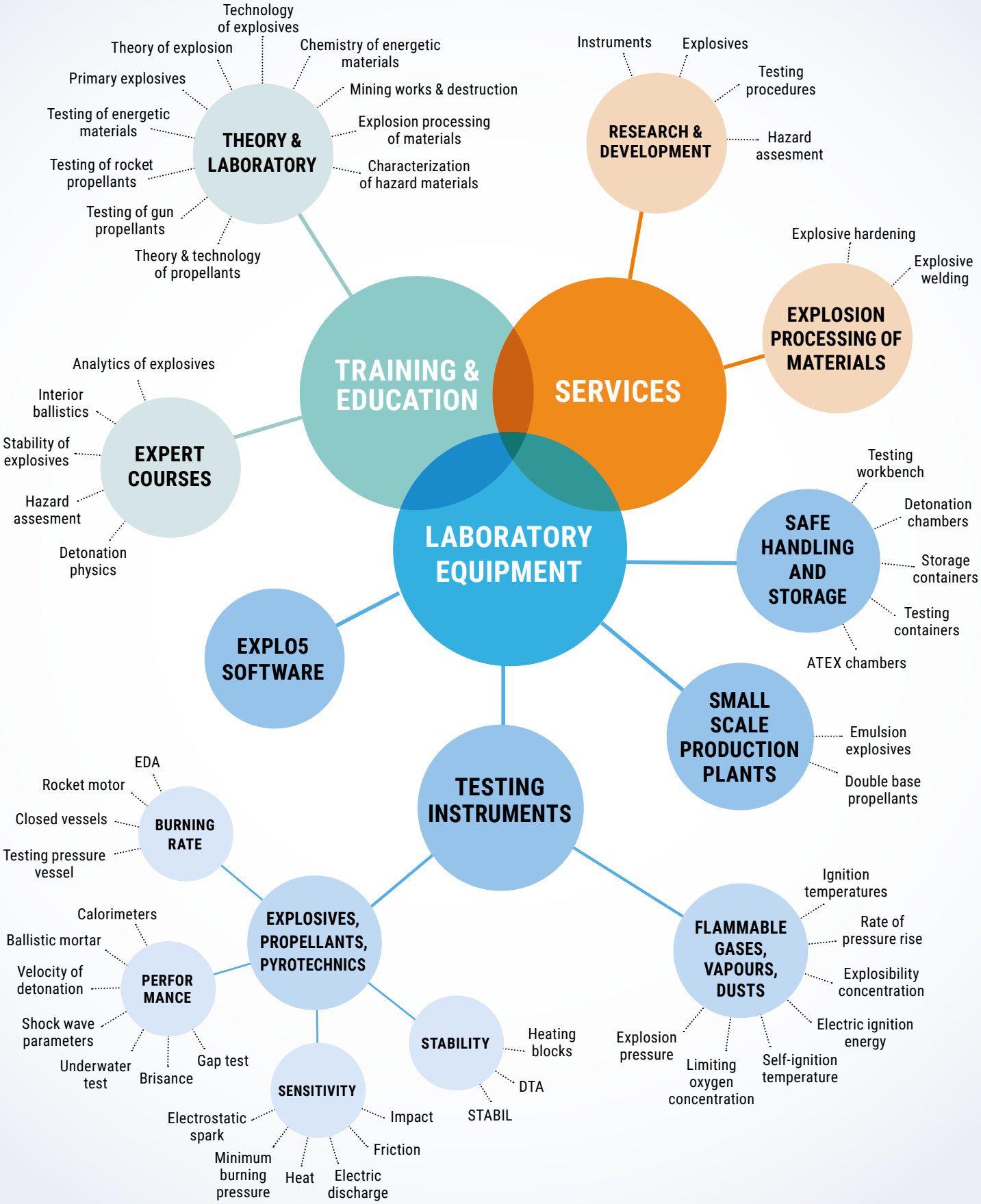
Advanced Testing Instruments

for Explosive Materials, Rocket Sciences and Detonation Physics

PRODUCT CATALOGUE

2023/2024

www.ozm.cz


TRAINING & EDUCATION
SERVICES
LABORATORY EQUIPMENT
THEORY & LABORATORY
Technology of explosives
Theory of explosion
Chemistry of energetic materials
Primary explosives
Mining works & destruction
Testing of energetic materials
Explosion processing of materials
Testing of rocket propellants
Characterization of hazard materials
Testing of gun propellants
Theory & technology of propellants
RESEARCH & DEVELOPMENT
Instruments
Explosives
Testing procedures
Hazard assesment
EXPLOSION PROCESSING OF MATERIALS
Explosive hardening
Explosive welding
EXPERT COURSES
Analytics of explosives
Interior ballistics
Stability of explosives
Hazard assesment
Detonation physics
SAFE HANDLING AND STORAGE
Testing workbench
Detonation chambers
Storage containers
Testing containers
ATEX chambers
EXPLO5 SOFTWARE
SMALL SCALE PRODUCTION PLANTS
Emulsion explosives
Double base propellants
TESTING INSTRUMENTS
EXPLOSIVES, PROPELLANTS, PYROTECHNICS
BURNING RATE
EDA
Rocket motor
Closed vessels
Testing pressure vessel
PERFOR MANCE
Calorimeters
Ballistic mortar
Velocity of detonation
Shock wave parameters
Underwater test
Brisance
Gap test
SENSITIVITY
Electrostatic spark
Impact
Minimum burning pressure
Heat
Electric discharge
Friction
STABILITY
Heating blocks
DTA
STABIL
FLAMMABLE GASES, VAPOURS, DUSTS
Ignition temperatures
Rate of pressure rise
Explosibility concentration
Electric ignition energy
Explosion pressure
Limiting oxygen concentration
Self-ignition temperature

OZM Research

KNOWLEDGE-BASED COMPANY

OZM Research is a knowledge-based company formed by experienced explosives scientists and engineers. The company's core business model is to produce the best specialized testing instruments for the energetic and hazardous flammable materials using the latest technologies and to provide our clients the most comprehensive expert services for their applications.

CLIENT FOCUSED

Our services do not just end with the sale and delivery of the instruments. Our product managers are PhDs in explosives science and technology with decades of experience in development and applications of new testing methods and instruments in academic, industrial and military domestic and international projects. We offer our clients our expertise throughout the entire process — from selecting an instrumentation for a specific application, to its installation and training, to preparation of testing methodologies and their implementation at the client's laboratory.

TAILORED PRODUCTS

We offer not only standard testing equipment complying with the military or industrial standards as shown in this catalog. We often design tailored products meeting the client 's specific requirements. Please do not hesitate to challenge our engineers with a request for a new instrumentation if not finding the appropriate type in our catalog.

EXPORT ORIENTED

Since the company establishment in 1997, we have exported our products to more than 50 countries on all continents. Our major clients include military research & development centers, forensic institutes, international certification bodies, universities, explosives and ammunition manufacturers, nuclear power plants and other related industries. Our company is fully licensed for handling explosive materials and ammunition as well as for foreign trade with these materials.

UPGRADE

BCA® 500

HIGH PRESSURE BOMB CALORIMETER

See Page **44**

UPGRADE

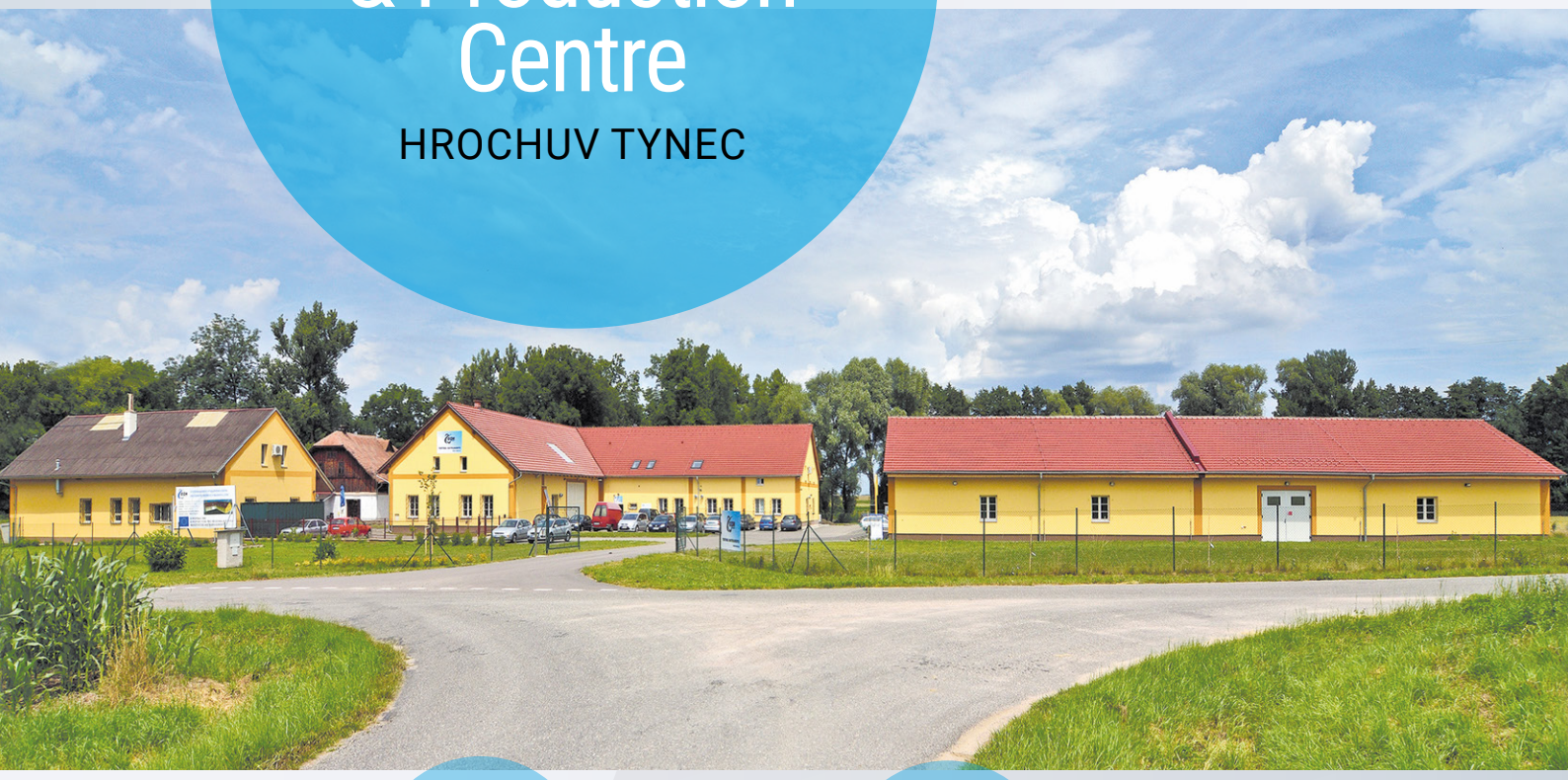
SSB™

BURNING RATE MEASUREMENT

See Page **60**

Headquarters, Development & Production Centre

HROCHUV TYNEC



ALL IN ONE

- Design
- Testing
- Development
- Support
- Production
- Education
- Training

We always looking forward
to new partnership
in research and inovation

Research & Development Centre

PARDUBICE-RYBITVI

Research and development centre – Pardubice-Rybitvi

- Laboratories
- Detonation testing bunker 800 m^3/12 kg TNT eq.
- Detonation chambers up to 2 kg of TNT eq.
- Specialised instruments for testing of detonation and shock wave parameters

Collaborative laboratory for research of detonation synthesis with Czech Academy of Science

Research on detonation nanodiamonds (DND)

- Development of new industrial explosives, special instrumentation and detonation chambers for detonation synthesis of nanodiamonds
- Preparation of the detonation nanodiamonds with high yield and defined parameters
- Development of purification methods to obtain high-purity DND

OZM TEAM

Miloslav KRUPKA Ph.D.

Co-CEO, Co-Founder & Owner

Dr. Krupka leads OZM Research's business enterprise strategy and personally participates in the development of new instruments and methods for the testing of Energetic Materials. Since 1995 he has developed and introduced more than twenty different instruments to the international market. He brings new ideas and the vision to further expansion of OZM Research's business activities.

Before OZM Research's founding in 1997, Dr. Krupka worked at the Institute of Energetic Materials, University of Pardubice, as an assistant professor. He received a Master's (1993) and Ph.D. (2000) in the Technology of Explosives from the Institute of Energetic Materials, University of Pardubice.

Jan CUPÁK

Product Manager

Mr. Cupák is an expert in the design of advanced electronic hardware, responsible for development of the electronic parts of the OZM Research instrumentation.

Mr. Cupák received his Master's degree in the Electrical Engineering from the Brno University of Technology in 2011 and began his professional career at Chromservis company. In 2014 he joined OZM Research and started here a new branch for development of advanced laboratory equipment for CBRN defense.

Marcel HANUS, Ph.D.

Product Manager

Dr. Hanus is a product manager for detonation chambers and explosion-proof containers. Dr. Hanus is a graduate from the Institute of Energetic Materials, University of Pardubice, with M.Sc. (1996) and Ph.D. (1999) degrees. He joined OZM Research in 2004. He has also six years of experience as a defense scientist at the Military Institute for Weapon and Ammunition Technology. He was responsible for the transformation of the Czech Army methodologies for qualification and in-service surveillance of explosive materials to modern NATO standards, the development of new testing methods for service life control of explosive materials in rockets and missiles, development of ammunition demilitarization technologies and enhanced blast explosives. He acted as the national representative in NATO committees for testing of explosive materials AC/310 SG1 and AC/326 SG1 (1998–2006), wrote more than 100 R&D reports and technical documents, 3 NATO standards, 3 Czech defense standards, 19 papers at scientific conferences, 1 monograph and 1 university textbook.

Jan HORKEL

Product Manager

Mr. Horkel specializes in the development and production of instrumentation for testing sensitivity of explosive materials and other dangerous substances to impact, friction and flame.

Mr. Horkel is a graduate from the Institute of Energetic Materials, University of Pardubice, with M.Sc. (2004) in Safety Engineering. Mr. Horkel joined OZM Research in 2006, and under his leadership, more than 250 instruments have been produced for customers in more than 50 countries worldwide.

PRODUCT MANAGERS / DEVELOPMENT TEAM

Jindřich KUČERA, Ph.D.

Product Manager

Dr. Kučera holds a Master's (2016) and Ph.D. degree (2021) in Technology of Explosives from the Institute of Energetic Materials, University of Pardubice. He is responsible for different kinds of calorimeters, laboratory detonation chamber and some of thermal stability lectures. His career in OZM began as a Ph.D. student in external cooperation on testing of optical instruments. After studies he worked as a researcher in the field of detonation synthesis of nanodiamonds. His research experience includes experimental detonation physics or visualization techniques in laboratory scale or field experiments for blast waves research. He contributed on several journal articles and more than 20 papers on international conferences.

Martin KÜNZEL, Ph.D.

Product Manager

Dr. Künzel is responsible for the development and production of passive optical and active laser-based instruments for determination of detonation parameters. He also performs EXPLO5 training courses.

Dr. Künzel received his Master's (2011) and Ph.D. (2018) in Technology of Explosives from the Institute of Energetic Materials, University of Pardubice. During his studies, he authored more than 10 scientific journal articles in the field of energetic materials. He joined OZM in 2015.

Václav STANĚK, Ph.D.

Product Manager

Dr. Staněk is responsible for the development of new testing procedures, standards and application lists, especially for analytical instruments. He also participates in the development of new technologies for production of energetic materials.

Dr. Staněk received his Master's (1994) and Ph.D. (2001) in Analytical Chemistry from the Department of Analytical Chemistry, University of Pardubice. He joined OZM Research in 2017. Prior to that, he worked more than 15 years as an assistant professor at the Department of Analytical Chemistry, University of Pardubice and later as a validation specialist at ALS Czech Republic, Life Sciences Division.

Petr STOJAN, Ph.D.

Product Manager

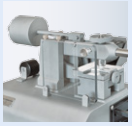
Dr. Stojan is responsible for the development of instruments designed for the testing of ballistic parameters of propellants. He invented the unique instrument and procedure for the determination of the burning rates of propellants called the STOJAN Vessel and many others.

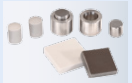
Dr. Stojan received his Master's (1996) and Ph.D. (2004) from the Brno University of Technology. Before joining OZM Research, his experience included internal ballistics, testing and technology of double and triple base propellants (in/for rocket motors and large caliber guns) and their application at the Research Institute of Industrial Chemistry of Explosia Pardubice.

CONTENT

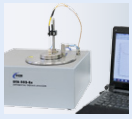
ENERGETIC MATERIALS

SENSITIVITY TESTING





STABILITY TESTING



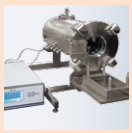
EXPLOSIVE PERFORMANCE TESTING

ENERGETIC MATERIALS

EXPLOSIVE PERFORMANCE TESTING

INTERIOR BALLISTIC & ROCKET PROPELLANTS TESTING

SAFE STORAGE AND TESTING IN LABORATORIES



FLAMMABLE MATERIALS & SAFETY ENGINEERING

TRAINING AND EDUCATION

STANDARDS OF TESTING

LIST OF STANDARDS / COMPLIED INSTRUMENTS / PAGE

Standard	Instrument	Page
A		
AOP 7	ABT	39
	BFH PEx	27
	BIT 132	27
	FSKM 10	28
	FSA 12	29
	KT 300	30
AOP 48	HBA	40
AS 1038.5	BCA 500	44
ASTM D240, D4809, D5468, D5865	BCA 500	44
ASTM E711	BCA 500	44
C		
CSN EN 14918	BCA 500	44
D		
DEFSTAN 13-189/1	ABT	39
DIN 51 900	BCA 500	44
E		
EC 440	BFH Series	24
	FSKM 10	28
	FSA 12	29
	KT 300	30
ECD 2004/73/EC	TPT Series	34
EMTAP Manual of Tests / Test No 43	BFH Series	24
EMTAP Manual of Tests / Test No 44	FSKM 10	28
	FSA 12	29
EN 13630-11	OPTIMEX 8	47
	OPTIMEX 64	48
	VOD 815	46
EN 13631-3	FSKM 10	28
	FSA 12	29
EN 13631-4	BFH Series	24
EN 13631-14	OPTIMEX 8	47
	OPTIMEX 64	48
	VOD 815	46
EN 13631-15	EXPLO5	52
EN 13763-13	L SPARK	22
EN 13763-16	EDA	56
EN 13763-17	EDA	56
EN 13763-18	EDA	56
EN 13763-19	EDA	56
EN 13763-20	EDA	56
EN 13763-21	L SPARK	22
EN 13763-23	OPTIMEX 8	47
	OPTIMEX 64	48
EN 13938-2	L SPARK	22
	X SPARK 10	20
EN 16265	EDA	56
	L SPARK	22
EN IEC 62133-2	BET 22	68
EN IEC 62660-2	BET 22	68
EN IEC 62660-3	BET 22	68
G		
GB/T 21566-2008	FSKM 10	28
	FSA 12	29
GB/T 21567-2008	BFH Series	24
I		
IS 1350-2	BCA 500	44
ISO 14451-2	EDA	56
ISO 1928	BCA 500	44
J		
JIS M 8814	BCA 500	44

Standard	Instrument	Page
M		
MIL-DTL-244B	ABT	39
MIL-DTL-244C	BEJU	39
	MVT	39
MIL-STD-286C	BCA 500	44
	DCA 25	45
	MVT	39
	RB Series	55
	SSB	60
MIL-STD-1751A	BFH Series	24
	BIT 132	27
	FSKM 10	28
	FSA 12	29
	X SPARK 10	20
S		
SAE/USCAR 28	EDA	56
STANAG 4022/4	STABIL VI	36
STANAG 4023	STABIL VI	36
STANAG 4115	RB Series	55
STANAG 4117	HBA	40
STANAG 4147	STABIL VI	36
STANAG 4178	ABT	39
	BEJU	39
	MVT	39
STANAG 4230	STABIL VI	36
STANAG 4284	STABIL VI	36
STANAG 4487	FSKM 10	28
	FSA 12	29
STANAG 4489	BFH Series	24
STANAG 4490	X SPARK 10	20
STANAG 4491	AET 402	42
	KT 300	30
STANAG 4515	DTA 552-Ex	41
STANAG 4527	HBA	40
STANAG 4541	HBA	40
STANAG 4556	STABIL VI	36
STANAG 4566	STABIL VI	36
STANAG 4620	HBA	40
STANAG 4672	LTRM	61
	TRM 50	62
STANAG 4673	LTRM	61
	TRM 50	62
T		
TL 1376-0589	BEJU	39
TL 1376-0600	BEJU	39
	HT	40
U		
UK M28/89	BEJU	39
UN RTDG *) Appendix 7	TPT Series	34
UN RTDG *) Test 1(b), Test 2(b)	KT 300	30
UN RTDG *) Test 1(c)(i), Test 2(c)(i)	TPT Series	34
UN RTDG *) Test 3(a)(ii)	BFH Series	24
UN RTDG *) Test 3(b)(i)	FSKM 10	28
	FSA 12	29
UN RTDG *) Test 8(c)	KT 300	30
UN RTDG *) Test C.1	TPT Series	34
UN RTDG *) Test E.1	KT 300	30
UN RTDG *) Test F.5	HPA 1500	33
UN RTDG *) Test O.1, Test O.2	TPT Series	34
UN RTDG *) Test T.5, Test T.7	BET 22	68
US ARMY TB 700-2	FSKM 10	28
	FSA 12	29

*) **UN RTDG** = UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria, United Nations, New York, 2015

ENERGETIC MATERIALS

TESTING INSTRUMENTS FOR THERMAL STABILITY, SENSITIVITY AND PERFORMANCE TESTS

Characterization of properties of energetic materials is extremely important when considering their manipulation safety or long-term storage. OZM Research provides complete solution for explosive testing laboratories.

Sensitivity testing provides information about energy sufficient for initiation of explosive samples by impact, friction, spark, heat or shock wave stimuli.

Chemical and thermal stability testing is important for evaluation of service life of energetic materials to protect against accidental explosion during long-term storage.

Performance tests allow to evaluate how good certain explosive is for a particular mission. Determination of combustion and detonation heat, detonation velocity or other performance properties is very important for assessment of high explosives in industrial or military applications.

Solid gun and rocket propellants are subjected to the series of interior ballistic tests. Closed vessels of different volumes serve for determination of burning vivacity and maximum working pressure of gun propellants. Burning rate of the solid rocket propellants can be measured directly in real or subscale rocket motors or in specially developed Stojan Vessel®.

INSTRUMENTS APPLICATIONS REFERENCE TABLE

● Applicable
○ Limited usage

	▼ Test Method	▼ OZM Instrument	EXPLOSIVE MATERIALS							APPLICATIONS					
			Primary Explosives	Military High Explosives	Industrial Explosives	Pyrotechnics	Gun Propellants	Rocket Propellants	Explosive Devices	Research & Development	Qualification for service	Product quality control	In-service surveillance	Storage & transport safety	Ammunition demilitarization
Chemical and Thermal Stability Tests	Abel Test	**ABT**			●		●	●		○		●	○		●
	Accelerated Ageing	**HBA, Heating Blocks**	●	●		●	●	●	●	●	●		●		
	Bergmann-Junk Test	**BeJu**					●	●		○		●	●		●
	Differential Thermal Analysis (DTA)	**DTA 552-Ex**	●	●	●	●	●	●		●	●	●	●	●	●
	Dutch Weight Loss Test at 90 °C (Holland Test)	**HOLLAND TEST**					●	●		○		●	●		●
	Explosion (Ignition) Temperature Test	**AET 402**	○	●	●	●	○	○		○	●	●	○		○
	Heat Storage Test at 100 °C	**CH 100**					●	●		●		●	●		
	Compatibility/Reactivity by DTA	**DTA 552-Ex**	●	●	●	●	○	○		●	●				
	Compatibility/Reactivity by VST	**STABIL VI**		●	●	○	●	●		●	●				
	Methyl Violet Test	**MVT**					●	●		○		●	●		●
	Time-to-Explosion Test	**AET 402**	●	●	●	●	●	●		●					
	Vacuum Stability Test (VST)	**STABIL VI**	○	●	●	○	●	●		●	●	●	●		●
Sensitivity to External Stimuli Tests	Friction Sensitivity Test	**FSKM 10 (FSA 12)**	●	●	●	●	●	●		●	●	●		●	●
	Gap Tests (shock wave sensitivity)	**Water & UN GAP Test**	○	●	●	○	○	○	○	●	●	●		●	
	Impact Sensitivity Test	**BFH 10, BFH 12 , BFH 12A, BFH 12R**	○	●	●	●	●	●	○	●	●	●		●	●
	Impact Sensitivity Test	**BFH PEx**	●			●				●	●	●		●	●
	Large Scale Electrostatic Discharge Sensitivity Test	**ESD LS30**		●		○	●	●		●	●				
	Small Scale Electrostatic Spark Sensitivity Test	**L SPARK**	●	●	●	●	●	●	●	○	●	●	●	○	●
	Small Scale Electrostatic Spark Sensitivity Test	**X SPARK 10**	●	●	●	●	●	●		●	●	○	○	●	●
	Minimum Burning Pressure Test	**MBP**			●					●	●	●		●	
	Explosibility of Confined Heating	**TPT Series, HPA 1500, KT 300**		●	●	○	○	○		●	●			●	

INSTRUMENTS APPLICATIONS REFERENCE TABLE

● Applicable
○ Limited usage

	▼ Test Method	▼ OZM Instrument	EXPLOSIVE MATERIALS: Primary Explosives	Military High Explosives	Industrial Explosives	Pyrotechnics	Gun Propellants	Rocket Propellants	Explosive Devices	APPLICATIONS: Research & Development	Qualification for service	Product quality control	In-service surveillance	Storage & transport safety	Ammunition demilitarization
Explosive Performance Tests	Underwater Blast Test	**UWB**	●	●	●				●	●	●	●			
	Explosive Strength (power)	**Ballistic Mortars**	○	●	●				○	●	○	●			
	Explosive Strength (power)	**Trauzl Test, Detonation Chambers**	○	●	●				○	●	○	●			
	Explosive Brisance Tests	**Hess Test, Kast Test, Detonation Chambers**	○	●	●				○	●	○	●			
	Detonation Velocity	**VOD 815, Detonation Chambers**	○	●	●				○	●	●	●	●		
	Detonation Velocity, Burning Rate	**OPTIMEX 8 and 64, Detonation Chambers**	●	●	●	○	○	○	●	●	●	●	●		
	Cylinder Expansion Test, Flyer Plate Test, Fragment Velocity	**VELOREX PDV**	●	●	●				●	●	●	●			
	Prediction of Detonation and Burning Parameters	**EXPLO5**	●	●	●	●	●	●		●					
	Heat of Detonation	**DCA 25, DCA 100**	●	●	●	○	○	○		●	●				
Interior Ballistic Performance Tests	Closed Vessel Tests	**TSV Series**				●	●		●	●	●	●	●		
	Closed Vessel Tests	**RB Series**					●			●	●	●	●		
	Heat of Combustion/Explosion	**BCA 500**		●	●	●	●	●		●	●	●	●		
	Burning Rate Tests	**SV-2**						●		●	●	●	●		
	Burning Rate Tests	**SSB**						●		●	●	●	●		
	Burning Rate Tests	**LTRM**						●		●	●	●	●		
	Burning Rate Tests of Pyrotechnics	**OPTIMEX 64**				●				●	●	●	●		
	Sub-scale Rocket Motor Tests	**TRM 50**						●		●	●	●	●		
	Rocket Motor Burning Parameters	**RMM**						●	●	●	●	●	●		
	Electro-explosive Device Analyzer	**EDA**				●	●	●	●	●	●	●	●	●	

Typical testing programs for explosive materials

Research and development

Research and development of new Explosive Materials (EM) usually require the most extensive testing program. The initial formulation of EM can start with the **EXPLO5**, a thermochemical program for the calculation of explosion parameters of new substances and mixtures.

Experimental testing of newly developed EM typically begins with **small-scale** (sub gram-scale) **sensitivity to external stimuli** tests: impact (**BFH Series**), friction (**FSKM 10**) and electrostatic spark (**X SPARK 10**) for the characterization of their safety risks in handling.

Sensitivity testing of highly sensitive **primary explosives** pose special challenges because their sensitivity levels are typically in orders of the magnitude higher than that of other EM classes. This is why our instrumentation is either developed specifically for testing these very high sensitivity levels (such as **BFH PEx**) or with a very wide range of applicable testing energies to cover all EM classes (such as **X SPARK 10** or **FSKM 10**).

Special Closed Vessels Tests can reveal sample susceptibility to violent thermal explosions when ignited by a hot wire at initial normal (**TPT Series**) or high pressure (**MBP**) or when heated in an autoclave to high temperatures (**HPA 1500**).

When the results of the sensitivity tests are considered acceptable, **Small-Scale Stability Tests** (gram-scale) typically follow in order to prove that the developed EM is chemically and thermally stable enough to survive the storage and application temperatures for the whole service life of the EM, which can reach dozens of years.

Underestimation of the EM stability values can lead to devastating accidental explosions during their long-term storage or application (such as blasting in hot boreholes).

A very quick and complex picture of thermal behavior of EM can be obtained by thermal analysis, for which we developed **DTA 552-Ex** as the instrumentation robust and resistant enough to withstand explosion effects of the thermally activated samples.

Another powerful chemical stability test is the Vacuum Stability Test. The **STABIL VI** is a precise instrument that continuously records the volume of the evolved gases while providing more relevant information on the behavior of the sample than subjective classic heat tests. Both **DTA 552-Ex** and **STABIL VI** can also be used for the determination of **chemical compatibility** of EM with their contact materials (plastics, metals, lacquers etc.) in final applications.

Performance properties of high explosives can be thoroughly tested by various methods from small-scale tests suitable for labs of any size to highly specialized instruments capable of varied and explicit analysis of a load of up to 2 kg TNT.

Small-Scale Tests such as detonation heat determination (**DCA 25-100**) start the list and it continues with the Underwater Blast Test (**UWB**) and the Ballistic Mortar Test (**BM**), all of which require only a few dozens of grams of a sample.

Detonation processes can be further examined by multi-channel measurement of the detonation velocity (**VOD 815**). A more advanced instrument, the **OPTIMEX 64**, provides precise measurements of detonation wave speed and curvature, shock wave propagation in inert materials or charge case expansion (with up to 64 optical channels on samples as small as a detonator). **VeloreX PDV** is a high-speed Photonic Doppler Velocimeter capable of measuring speeds of multiple flying objects up to 10 km/s range. It is thereby applicable for Flyer Plate Test, Cylinder Expansion Test or Initial fragment velocity tests. The small-scale detonation experiments (up to 2 kg TNT load) can be safely executed directly in explosives laboratories themselves using laboratory detonation chambers or industrial detonation chambers and can also include measurements of the shock waves parameters – pressure, impulse, heat flow.

Performance properties of pyrotechnic mixtures can be effectively tested by the determination of their explosion

heat. The **BCA 500** is designed specifically for measuring the calorimetry of EM. Their burning speeds, pressure and optical profiles can be analyzed in Closed Vessel Tests (**TSV Series**) as well as by the **OPTIMEX 64** optical analyzer.

The interior ballistic performance of gun propellants can be studied using explosion heat determination (**BCA 500**) and by Closed Vessel Tests of various sizes (**RB Series**) for pressure-time analysis of their burning behavior. **VeloreX PDV** can be used for the unique measurement of the projectile acceleration directly inside a gun barrel.

There are a wide range of **performance tests for solid rocket propellants** available for characterizing all relevant internal ballistic properties, starting with explosion heat determination (**BCA 500**), through small-scale advanced burning rate tests (**SV-2**, **SSB**) to Sub-Scale Rocket Motor Tests (**TRM 50**) and Full-Scale Rocket Motor Tests (**RMM**).

Performance parameters of assembled **Electro-Explosive Devices** (EED), **Cartridge-Actuated Devices** (CAD) and **Propellant-Actuated Devices** (PAD), can be analyzed using a precision current source with a defined ignition impulse (**EDA**), combined with customized closed vessels for measuring pressure-time profiles (**TSV Series**) or with Rocket Motor Stands (**RMM**) for measuring pressure and thrust profiles.

Tests involving the initiation to explosion or having a higher probability of an accidental explosion during execution (large-scale stability and sensitivity tests) can be safely carried out using laboratory or industrial detonation chambers directly inside explosives laboratories.

Newly synthesized samples of unknown properties, highly sensitive or unstable samples need to be **safely stored and transported**, for which our explosion-resistant containers can be used. Storage modules allow for the effective storage of samples of different hazard and compatibility classes conveniently inside research and development laboratories.

Product quality control

Quality Control (QC) tests of EM carried out during their manufacture or at the customer's acceptance are mainly focused on testing eventual changes in selected stability or performance properties induced by manufacturing process irregularities. The selected tests shall be both fast and representative enough to be easily incorporated into the manufacturing process.

To assure chemical stability of the manufactured EM, the modern Vacuum Stability Test (**STABIL VI**) is widely used for high explosives, as well as for gun and rocket propellants, allowing several dozens of samples to be tested simultaneously with the very precise instrumentation. Simple classic heat stability tests, such as Abel Test, Methyl-Violet Test, Bergmann-Junk Test, Heat Storage Test or Holland Test are however still applied for this purpose as well at nitrocellulose propellants plants, mainly with respect to databases of historical results.

Similarly, the **AET 402** tester allows to automatically detect explosion (ignition) temperature of high explosives or pyrotechnics with up to 5 samples simultaneously. The **DTA 552-Ex** can also provide important details on the purity (melting point, phase transitions) and the stability (thermal decomposition onsets and peaks) of high explosives and pyrotechnics.

Selected sensitivity tests, such as friction (**FSKM 10**), impact (**BFH Series**) or electrostatic spark (**X SPARK 10**, **L SPARK**) can reveal the influences of grain parameters, mixing quality and contaminants in primary explosives, sensitive high explosives and pyrotechnic mixtures. **MBP** is a novel test method capable of revealing the excessive sensitivity of Emulsion Explosives which might lead to accidental explosions during their mixing or pumping.

Performance tests usually show the quality issues of EM with the highest reliability. Explosion heat determination

(using **BCA 500**) is one of the most representative and fast QC tests for all classes of EM. High explosive charges can then be tested by the determination of detonation velocity (**VOD 815** or **OPTIMEX 64**) and explosive power (**BM** or **UWB**). Closed Vessel Tests (**TSV Series**, **RB Series**) are the most widely used for testing quality of gun propellants and pyrotechnics. Advanced burning rate tests such as the **SV-2** or the **SSB** can reveal several quality-related parameters of rocket propellants, which also might be tested in sub-scale (**TRM 50**) or full-scale (**RMM**) rocket motor configurations. The **EDA** analyzer alone or in combination with closed vessels (**TSV Series**, **RB Series**) or rocket motor stands (**TRM 50**, **RMM**) allow for the precise characterization of performance parameters (safe/fire currents, ignition delay, pressure-time profiles, thrust-time profiles) of various electric initiators, Electro-Explosive Devices, Cartridge-Actuated Devices and Propellant-Actuated Devices.

Storage and transport classification

International treaties for the transport of dangerous goods reflected in the UN Recommendations for the Transport of Dangerous Goods ("UN Orange Book") define tests and their criteria for assuring minimum standards for safe storage, handling and shipping of explosive materials and articles. They also classify the substances and articles into specific hazard classes with different safety restrictions, which are directly reflected in higher of lower costs connected with their storage and transport.

The prescribed classification procedures cover thermal stability (**TST 75**), sensitivity to impact (**BFH Series**), friction (**FSKM 10**), shock wave (various cap sensitivity and gap tests), bullet impact, confined heating (time/pressure test **TPT Series**, Koenen Test **KT 300**), cook-off (external fire) tests, drop tests, deflagration-to-detonation transition or sympathetic explosion tests.

Samples can be safely shipped to classification or round robin tests in our explosion-proof containers effectively reducing their hazard division to convenient 1.4S class.

Qualification for commercial service

Qualification programs for commercial EM, such as those described in the European Union standard series of EN 13631 (for high explosives), EN 13938 (for gun and rocket propellants) or EN 13763 (for detonators and relays) are significantly less extensive than those for the military EM mentioned above, given a much shorter shelf life and a narrower range of environmental conditions for their use. The testing programs include the determination of thermal stability (**TST 75**) and sensitivity to impact (**BFH Series**), friction (**FSKM 10**) and electrostatic spark (**X SPARK 10**).

Performance properties of high explosives are typically tested with detonation velocity measurements (**VOD 815**, **OPTIMEX 64**), sensitivity to initiation and transmission of detonation, along with water resistance and reliability at extreme temperatures, which can also be tested in laboratory or industrial detonation chambers.

Electro-Explosive Analyzer **EDA** can be effectively used for a number of standardized tests of electric detonators and squibs, such as the determination of the all-fire/no-fire currents, firing impulse or delay accuracy.

Qualification
for military service

Qualification programs for military service of new or modified EM, such as those defined in NATO STANAG 4170, usually involve tests very similar to those applied in research and development described above, but carried out by independent national authorities. These programs also start with small-scale sensitivity tests (such as the **BFH Series**, **FSKM 10** and **X SPARK 10**) and stability tests (such as **DTA 552-Ex** and **STABIL VI**).

Large-scale tests simulating real threats, such as cook-off, shock wave impact or intensive electrostatic discharge (**ESD LS30**) are also applied. Performance properties of various classes of EM are tested by the same methods as used in their research and development programs, discussed above.

Qualification programs put more stress on the comparative assessment of the new or modified EM with results obtained from standard EM with proven suitability and reliability in a long-term service, which can reach dozens of years in very harsh environmental conditions. This is why qualification programs involve artificial ageing tests (using e.g. **HBA** heating blocks) and repeated sensitivity, stability and performance testing of aged samples to prove that the EM can keep their safety and suitability properties for their whole service life. The testing is also carried out at application temperature limits causing the highest stress to the explosive materials to confirm their safety and suitability at these edge conditions.

Surveillance
of in-service explosive materials

Surveillance programs shall assure that EM are maintaining their safety and reliability for service during their long-term storage in ammunition in various climatic conditions. The surveillance programs focus on periodical testing of properties, of the stored EM, that are likely to deteriorate during ageing accelerated by incompatibility reactions with contact materials and climatic influences causing safety or performance issues.

Selected systems are tested at the both edges of their application temperature range as well as subjected to artificial ageing assuring the suitability of the tested systems till the next testing period. Samples, stored at equivalent climatic conditions, of each lot of the EM shall be periodically tested, which in turn requires a selection of high-volume, fast and representative tests. The range of these tests is similar to those for the QC of manufactured EM as described above.

The most critical safety issue is the tendency of nitrocellulose-based gun and rocket propellants to self-heat during their gradual chemical decomposition. This decomposition reaction is a frequent cause of devastating accidental explosions of ammunition magazines. This is why multiple independent tests methods are usually applied for the propellant surveillance, including stabilizer depletion (HPLC), heat-flow calorimetry (HFC), Vacuum Stability Test (**STABIL VI**) and classic heat tests. The stability of high explosives is influenced mainly by long-term incompatibility reactions with contact materials in munitions, which are most reliably detectable by the Vacuum Stability Test (**STABIL VI**) and thermal analysis (**DTA 552-Ex**).

Explosion calorimetry (**BCA 500**) is able to detect even small ageing changes which can significantly influence the performance properties of all EM classes – propellants (nitrogen content reduction by nitrocellulose decomposition), high explosives or pyrotechnics (drop in active metal content by reactions with humidity). Deteriorated physical and mechanical properties of aged gun and rocket propellants are also reflected in modified ballistic

performance parameters, which can lead to tragic weapon system failures. These changes are best monitored using Closed Vessel Tests (**TSV Series**, **RB Series**) for gun propellants, as well as **SV-2**, **SSB**, **TRM 50** and **RMM** tests for rocket propellants. Ageing of multiple components in assembled explosive devices (initiators, EED, CAD, PAD) can be identified exactly using the **EDA** analyzer capable of characterizing firing sensitivity, initiation delays as well as pressure-time and thrust-time burning profiles.

Ammunition demilitarization

Ammunition with expired service life need to be safely and environmentally friendly disposed in a relatively short time frame in order to eliminate risks of its accidental explosion in prolonged storage. The most environmentally friendly and cost-effective ammunition demilitarization methods are based on the ammunition disassembly and recycling of recovered metals and separated EM. Separation of EM from projectiles or rocket motors often involves methods causing thermal (melt-out) or mechanical (drilling, machining, press-out, wash-out) stress to the EM, which needs to be properly characterized to avoid accidental explosions during the demilitarization process. Aged EM can have significantly decreased chemical stability and increased sensitivity to external stimuli due to contamination with contact materials (lacquers, waxes, rust, dirt). These factors need to be carefully characterized first before developing the appropriate demilitarization technologies and later adopted in QC procedures during their operation.

Instrumentation testing sensitivity to impact (**BFH Series**), friction (**FSKM 10**) and electrostatic spark (**X SPARK 10**, **L SPARK**) are most suitable for determining the risk levels of demilitarization procedures, while thermal analysis (**DTA 552-Ex**) and vacuum stability test (**STABIL VI**) are two of the best methods to assure appropriate thermal and chemical stability of demilitarized EM. Other stability testing methods, such as stabilizer depletion (HPLC) or classic heat tests are however applied as well.

Recovered high explosives, as well as gun and rocket propellants, can be effectively reformulated into commercial blasting agents, which need to be verified by the methods described above at the Qualification for commercial use, Product quality control and Storage and transport classification sections.

SENSITIVITY TESTING

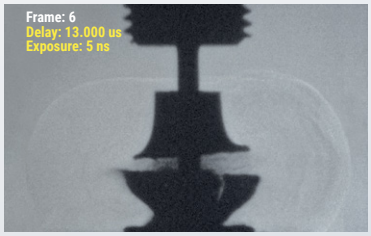
Characterization of sensitivity of explosive materials to external stimuli (impact, friction, electrostatic spark, heat, shock wave) allows to quantify risks in manufacture, handling, processing, demilitarization and transportation of these materials. It is thus the critical and usually initial part of all testing programs for energetic materials.

X SPARK 10

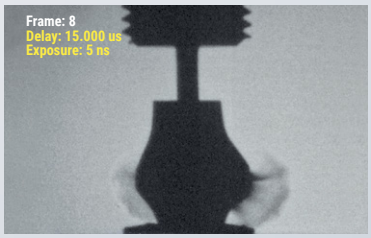
ADVANCED ELECTROSTATIC SPARK SENSITIVITY APPARATUS

The X SPARK 10™ is the newest generation of the universal testing instrumentation designed for the precise evaluation of the sensitivity of energetic materials to electrostatic spark in the range of discharge energies from 25 µJ to 17.5 J and voltages between 500 V and 10 kV.

Testing of electrostatic spark sensitivity together with testing sensitivity to both impact and friction, are crucial methods for the determination of safety parameters. The X SPARK 10 provides the precise measurement of spark energy of initiation for a wide range of crystalline energetic materials from primary explosives to low sensitive plastic explosives.



Ignition – detonation of a primary explosive



Ignition – burning of a pyrotechnic mixture

APPLICATIONS

Electrostatic discharge is one of the most frequent and the least characterized causes of accidental explosions of energetic materials. Together with friction and impact sensitivity, it provides the necessary information for safe handling and manufacture of the energetic materials.

Reliable data on the electrostatic spark sensitivity of energetic materials is thus critical for their manufacture, quality control, explosives processing, loading, transportation, storage, demilitarization and research and development of the new explosive materials.

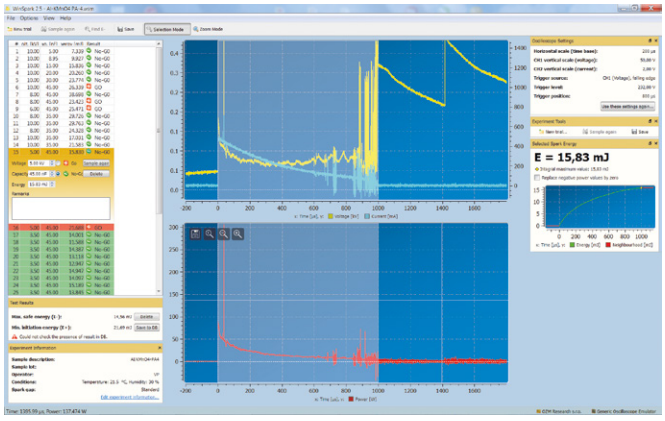
ADVANTAGES & FEATURES

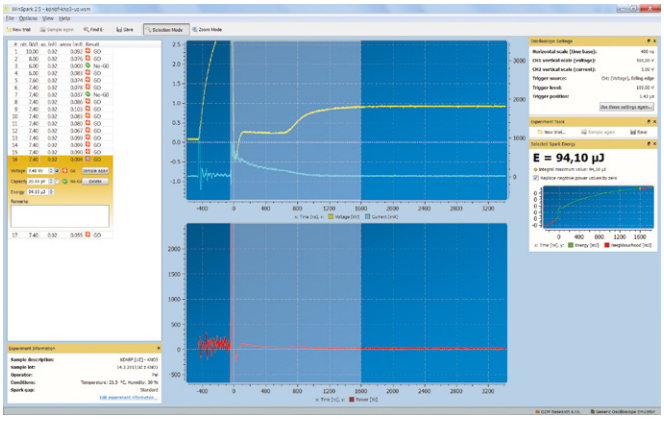
- Unique compact design
- Replaceable spark gaps
- Several models of automatically operated testing stands according to different international standards including stands with fixed electrodes and with an approaching anode
- Consumables at affordable prices
- Modified designs of the spark gap assemblies according to the requirements of other standards or testing methods are available upon request
- External testing assemblies are designed for up to 500 mg explosive samples
- Wide selection of capacitors in the capacitor bank for testing with wide ranges of spark energies
- Easy implementation of the Standard Operation Procedures (SOP) and tailoring the testing procedures to the specific requirements


Approaching needle testing stand

COMPLIANCE

- **EN 13938-2**, Part 2
- **MIL-STD-1751A**, Method 1031 (Methods 1032 and 1033 avaible upon request)
- **STANAG 4490**





Winspark software screenshots

Other available version of spark testers

ESD LS30™

Large-scale electrostatic discharge sensitivity tester

L SPARK

ELECTROSTATIC SPARK SENSITIVITY TESTER

The L SPARK™ is the newest member of the family of instruments dedicated to the testing of ESD sensitivity of energetic materials. The L SPARK test instrument is designed for the testing of bare energetic materials (pyrotechnic compositions, primary and secondary explosives and propellants) in the granular bed form. The L SPARK is also capable of performing tests of the resistance of Electro-Explosive Devices (EED's) to ESD energy.

design by Jan ERMIS

For testing energetic substances the **L SPARK** employs the comparative method concept – the response of the tested material is compared with the reference material along with the known ESD behavior under the given discharge conditions. The **L SPARK** provides the user with basic information about the risk associated with the ESD event of the tested substance within the least time and at minimum costs. This principle of operation does not require any further energy evaluation or discharge diagnostics of the discharge.

APPLICATIONS

The **L SPARK** is suitable for applications where only a basic screening of the risk associated with granular energetic materials is required along with impact and friction sensitivity data. The **L SPARK**'s simple operation and low running costs allow for the testing of a large count of samples in a short period of time with minimal running costs. This feature makes the **L SPARK** ideally suited for production facilities (e.g. for periodic production tests, or for the quick assessments of new materials/components used in the manufacturing processes). Adoption of the EED´s testing capability makes the **L SPARK** a good choice for national notified bodies (testing/certification laboratories) or for manufactures of initiating devices such a igniters, squibs or detonators.

ADVANTAGES & FEATURES

- Compact design
- Low running costs
- Suitable for a quick basic screening of the risks associated with all types of granular explosives
- Optional available accessories expand the **L SPARK**'s capability for the testing of the ESD resistance of the Electro-Explosive Devices (detonators, igniters, squibs, etc.) according to the EN standardization
- External steel testing chamber (capacity up to 2-gram NEQ)
- The versatility of the spark gap geometry allows for the easy modification of the spark gap geometry

COMPLIANCE

- **EN 13763-13** Explosives for civil uses – Detonators and relays, Part 13: Determination of resistance of electric detonators against electrostatic discharge
- **EN 13763-21** Explosives for civil uses – Detonators and relays, Part 21: Determination of flash-over voltage of electric detonators
- **EN 16265** Pyrotechnic articles, Other pyrotechnic articles, Ignition devices: Test 6.3.19. for electric igniters
- **EN 13938-2** Explosives for civil uses – Propellants and rocket propellants, Part 2: Determination of resistance to electrostatic energy

Manually operated test stand

Capacitor selector switchboard

L SPARK™ vs. X SPARK 10™ Comparison of Technical Parameters

	L SPARK	X SPARK 10
Direct discharge energy evaluation	–	●
Automatic test stand function	–	●
ESD resistance of electro explosive devices	●	–
Static electrode test stand	●	●
Moving electrode test stand	–	●
Working voltage up to 10 kV	●	●
Set of external and built-in capacitors	●	●
Application of statistical testing procedures	–	●

● Supported – Not supported

Accessories

L SPARK™ vs. X SPARK 10™ Comparison of Applications

	L SPARK	X SPARK 10
Explosives, Propellants and Pyrotechnics	●	●
Explosive Devices (Explosive containing products, Electro Explosive Devices)	●	–
Research & Development	○	●
Service Qualification	●	●
Product Quality Control	●	○
In-service Surveillance	●	○
Storage & Transport Safety (Risk)	○	●
Ammunition Demilitarization	●	●

● Applicable ○ Limited use – Not supported

Resistor calibrating target

BFH SERIES

BAM FALL HAMMER SERIES

The BAM Fall Hammer (also known as BAM Impact Tester or BAM Drop Hammer) is designed to determine the sensitivity of explosive materials to the impact stimuli by a falling drop weight in accordance with the BAM procedure.

OZM Research manufactures four types of standard BAM Fall Hammers for measuring impact sensitivity of solid or liquid energetic materials (primary and secondary high explosives, propellants, pyrotechnics) and also other substances potentially sensitive to impact stimuli in the range of impact energies between 0.25 J and 100 J. Sensitivity of the most sensitive substances such as primary explosives or highly sensitive pyrotechnics can be measured in the range of impact energies from 0.025 J to 20 J on a specially developed BAM Fall Hammer **BFH PEx**.

APPLICATIONS

The sensitivity to impact stimuli is one of the most important characteristics of energetic materials defining their safety in handling, processing or transportation. Its determination is a necessary part of characterization of new explosives, modified formulations or manufacturing conditions. It is also used for defining influences of impurities or ageing, in the quality control of manufactured explosives, in surveillance of in-service explosives and in transport/storage classification of explosive materials.

ADVANTAGES & FEATURES

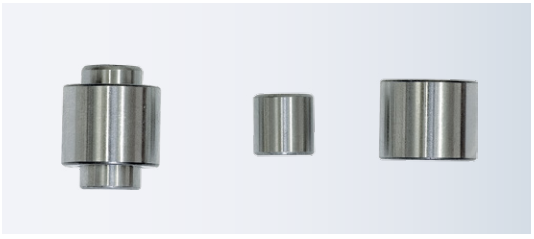
- Unique Drop Weight Exchange Window for safer, quicker and more convenient exchange of drop weights (**BFH 12A** and **BFH 12** only)
- Automated Lifting Mechanism remotely executes positioning, drop and collection of Drop Weight (**BFH 12A** only)
- Wide range of impact energies from 0.25 J to 100 J (seven drop weights from 0.25 kg to 10 kg)
- Drop weights are equipped with brass grooves to lower sliding friction
- High corrosion resistance of the critical parts
- Protective housing as a standard accessory
- Wide range of accessories

COMPLIANCE

OZM Research manufactures several modifications of this instrument in order to better fit different classes of explosive materials and different standards of testing, such as:

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria** – [13.4.2 – Test 3(a)(ii)]; [13.4.6 – Test 3(a)(vi)]
- **EN 13631-4:2002**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21567-2008**
- **STANAG 4489**
- **MIL-STD-1751A**, Method 1015 (BAM impact test)
- **MIL-STD-1751A**, Method 1012 & 1013 (Type 12 tools)
- **EMTAP**, Manual of Tests, Test No 43

Drop Weight Exchange Window


Steel cylinders and guide rings

Set of Drop Weights

BFH 10

STANDARD BAM FALL HAMMER

The **BFH 10**™ is fully functional standard model of BAM Fall Hammer, ideal for the customers who are looking for economy but still high-quality solution.

ADVANTAGES & FEATURES

- Remotely controlled Electromagnetic or Pneumatic release device
- Stainless steel guide rails
- Extra durable drop weights with corrosion-proof coating and modified to lower sliding friction
- Metric and logarithmic ruler
- Protective housing in standard
- Comply with all relevant international standards

BFH 12

IMPROVED BAM FALL HAMMER

The **BFH 12**™ is improved model of BAM Fall Hammer supplied by OZM Research. It is equipped with unique Drop Weight Exchange Window for safer, quicker and more convenient exchanges of the drop weights.

ADVANTAGES & FEATURES

- Remotely controlled Electromagnetic release device
- Drop Weight Exchange Window
- Drop height can be extended up to 2 meters
- Can be modified for determination of impact sensitivity of detonator according to EN 16763-3:2002
- Stainless steel guide rails
- Extra durable drop weights with corrosion-proof coating and modified to lower sliding friction
- Metric and logarithmic ruler
- Protective housing in standard
- Comply with all relevant international standards

BFH 12A

AUTOMATED BAM FALL HAMMER

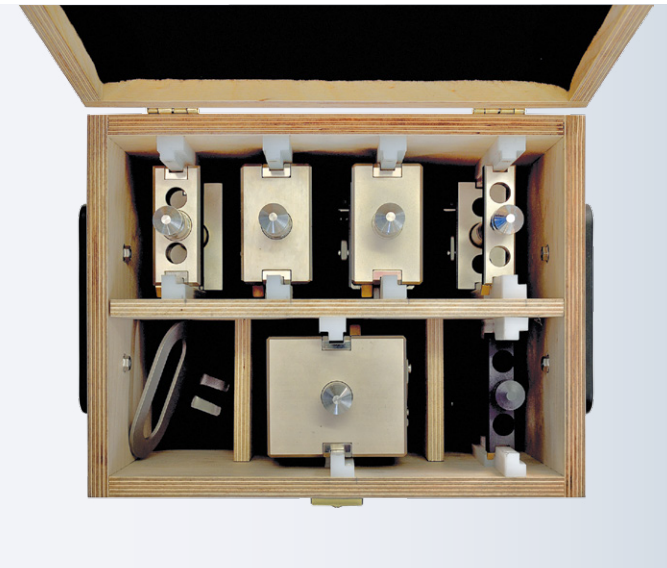
The BFH 12A™ is the top model of BAM Fall Hammer supplied by OZM Research. It is equipped with automated lifting mechanism for remote controlled positioning, drop and collection of the drop weight.

The **BFH 12A** also introduces a unique Drop Weight Exchange Window for safer, quicker and more convenient exchanges of the drop weights.

ADVANTAGES & FEATURES

- Remotely controlled Electromagnetic release device
- Automated Lifting Mechanism
- Drop Weight Exchange Window
- Remote control with inbuilt guide for Bruceton Up-and-Down procedure and export to PC available
- Drop height can be extended up to 2 meters
- Can be modified for determination of impact sensitivity of detonator according to EN 16763-3:2002
- Stainless steel guide rails
- Extra durable drop weights with corrosion-proof coating and modified to lower sliding friction
- Metric and logarithmic ruler
- Protective housing in standard
- Comply with all relevant international standards

Remote control



Storage case for drop weights

BFH PEx

BAM FALL HAMMER FOR HIGHLY SENSITIVE MATERIALS

The BFH PEx is designed specifically for determination of impact sensitivity of highly sensitive materials such as primary explosives and pyrotechnics in accordance with the BAM procedure.

APPLICATIONS

Reduced-size BAM Fall Hammer **BFH PEx** is especially suitable for testing the most sensitive energetic materials whose impact sensitivity is out of the range of the standard BAM Fall Hammer. The **BFH PEx** has been designed with special emphasis to the maximum operator's safety.

ADVANTAGES & FEATURES

- Entire corrosion-proof design
- Wide range of impact energies from 0.025 J to 20 J
- Six Drop Weights spanning from 25 grams to 2,000 grams
- Pneumatic or Electromagnetic Releasing Device for the remote controlled release of the drop weight
- Nickel-plated guide rails to reduce sliding friction
- Protective Housing as a standard accessory
- Wide range of accessories
- Premium quality consumables at affordable prices
- Metric and logarithmic ruler

COMPLIANCE

- **AOP 7** Ed.2; 201.01.005

BIT 132

BALL DROP IMPACT TEST

The Ball Drop Impact Test BIT 132 is designed to determine the impact sensitivity of various types of energetic materials ranging from the most sensitive primary explosives to less-sensitive high explosives and pyrotechnic mixtures. It uses steel balls with diameters from 0.5 inch (8.35 grams) to 2 inches (534.7 grams) as the drop weights.

ADVANTAGES & FEATURES

- Entire corrosion-proof design
- Solid but lightweight portable instrument (under 30 kg)
- Unique design of the ball tracks
- Drop height up to 100 cm or 40 inches
- Wide range of impact energies
- Ball catcher as a standard accessory
- Wide range of accessories

COMPLIANCE

- **AOP 7** Ed.2; 201.01.002
- **MIL-STD-1751A**, Method 1016

FSKM 10

BAM FRICTION APPARATUS

The BAM Friction Apparatus FSKM 10 is designed to determine sensitivity to friction stimuli of tested substances in the wide range of frictional loads between 0.1 N and 360 N.

The **FSKM 10** has a robust stainless-steel frame and it is equipped with a unique interchangeable loading arm mechanism. Thanks to that mechanism, all types of energetic materials can be tested on this single device.

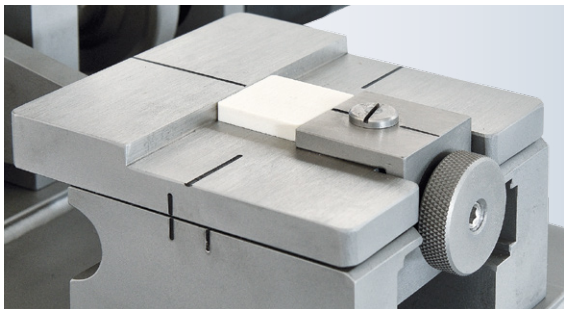
FSKM 10 equipped with safeguard

APPLICATIONS

Friction between hard surfaces is one of the most frequent causes of accidental explosions. The friction sensitivity of a tested substance is determined in accordance with the standardized BAM procedure using this BAM Friction Apparatus **FSKM 10**.

ADVANTAGES & FEATURES

- Unique interchangeable loading arm concept
- Standard 6-position loading arm accompanied by two sets of weights generating loads between 0.5 N and 360 N
- Lightweight 3-position loading arm, specially designed for testing highly sensitive substances, accompanied by two sets of weights generating loads between 0.1 N and 60 N
- OPTIONAL Protective shield to protect personnel against potential fragments
- Digitally controlled stepper motor for high precision movement of the porcelain plate carriage
- Working table with a stainless-steel frame covered by a conductive surface
- Variable speed of porcelain plate carriage between 20 and 300 RPM
- OPTIONAL Safeguard
- OPTIONAL Remote control
- Wide range of accessories
- Premium quality consumables at affordable prices



Porcelain plate carriage

6-position loading arm BAM 6A (dismantled)

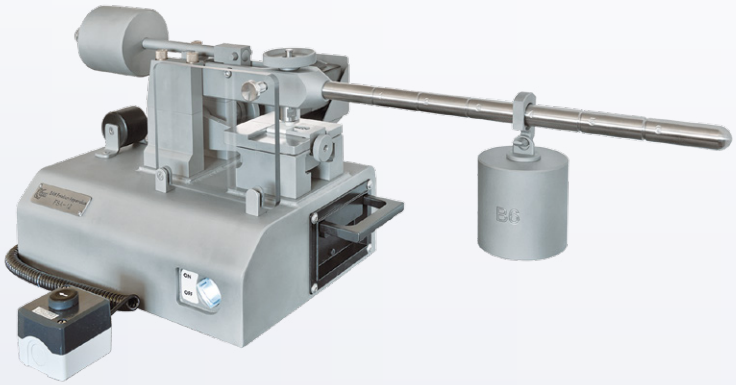
COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [13.4.2 Test 3(b)(i)]
- **EN 13631-3:2004**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21566-2008**
- **STANAG 4487**
- **AOP 7** Ed. 2, 201.02.006
- **MIL-STD-1751A**, Method 1024
- **US ARMY TB 700-2**, Section 5-3d
- **EMTAP**, Manual of Tests, Test No 44

FSA 12

BAM FRICTION APPARATUS

FSA 12™ is a portable version of the BAM Friction Apparatus FSKM 10 which can be placed and operated on a standard laboratory working table or supplied working table with conductive surface. FSA 12 is used to determine the friction sensitivity of all types of energetic materials in accordance with BAM procedure. Due to the unique design of two interchangeable loading arms, the applicable load can vary from 0.1 N to 360 N (from 0.01 kg to 36 kg).



APPLICATIONS

Friction between hard surfaces is one of the most frequent causes of accidental explosions. The friction sensitivity of a tested substance is determined in accordance with the standardized BAM procedure using this BAM Friction Apparatus **FSA 12**.

ADVANTAGES & FEATURES

- Unique interchangeable loading arm concept
- Standard 6-position loading arm accompanied by two sets of weights generating loads between 0.5 N and 360 N
- Lightweight 3-position loading arm, specially designed for testing highly sensitive substances, accompanied by two sets of weights generating loads between 0.1 N and 60 N
- OPTIONAL Protective shield to protect personnel against potential fragments
- Digitally controlled stepper motor for high precision movement of the porcelain plate carriage
- Hinged handles for easy transportation
- Remote control
- Wide range of accessories
- Premium quality consumables at affordable prices

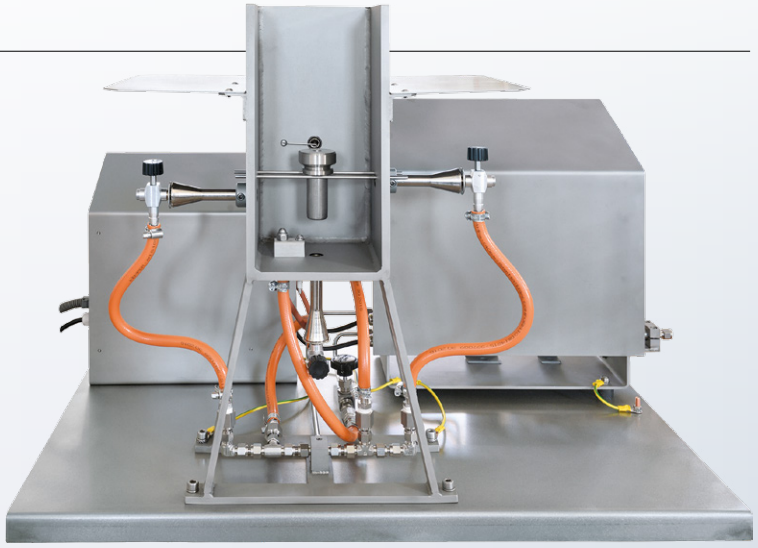
COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [13.4.2 Test 3(b)(i)]
- **EN 13631-3:2004**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21566-2008**
- **STANAG 4487**
- **AOP 7** Ed. 2, 201.02.006
- **MIL-STD-1751A**, Method 1024
- **US ARMY TB 700-2**, Section 5-3d
- **EMTAP**, Manual of Tests, Test No 44

Set of standard BAM weights

KT 300

KOENEN TEST



The Koenen Tester KT 300 is used to determine the reaction (explosibility) of solid or liquid substances when subjected to the intensive heat under heavy confinement.

The Koenen Tester KT 300 is designed as a "ready-to-use" solution consisting of a protective box, T-gas burners, pipeline and control units installed on a portable plaform.

APPLICATIONS

The Koenen test involves heating the tested substance in a steel tube closed by orifice plate with variable hole diameters, by the gas burners, to determine whether the substance can explode in the environment of intense heat under defined confinement. Data obtained from the Koenen test can be used in determining a substance's hazard classification for transport and storage and for evaluating the degree of venting required to avoid an explosion during processing operations.

ADVANTAGES & FEATURES

- Ready-to-use solution – all parts installed on a portable platform
- Durable design made of stainless steel
- Remotely operated via touch screen of a control unit
- Remotely ignited burners
- Remotely controlled and pneumatically actuated tamping device for sample preparation
- Full set of accessories and spare parts
- Premium quality consumables at affordable prices

Tamping device for sample preparation

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [11.5.1 Test 1(b)], [12.5.1 Test 2(b)], [18.6.1 Test 8(c)] and [25.4.1 Test E.1]
- **Council Regulation (EC) No 440/2008**; A.14
- **STANAG 4491**
- **AOP 7** Ed.2, 201.08.002

CONSUMABLES

FOR BAM FRICTION, BAM FALL HAMMER AND KOENEN TEST

OZM Research is a leading supplier of premium quality consumables for BAM Friction and BAM Fall hammer apparatuses and Koenen steel shell testers. All parts are manufactured with special attention to meet all requirements of relevant international standards, such as UN Recommendation on Transport of Dangerous Goods, European Union standards or STANAGs.

ADVANTAGES & FEATURES

- Manufactured in accordance with requirements of all relevant international standards
- Premium quality consumables at reasonable prices
- Leading supplier – quality and delivery stability
- Custom tailored solution upon request
- Further standard parts of BAM Friction and BAM Fall Hammer apparatuses and Koenen steel shell testers are also available

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria**, [13.4.2 – Test 3(a)(ii)]; [13.4.2 – Test 3(b)(i)]; [11.5.1 – Test 1(b)]
- **EN 13631-4:2002**
- **EN 13631-3:2004**
- **Council Regulation (EC) No 440/2008**; A.14
- **GB/T 21566-2008**
- **GB/T 21567-2008**
- **STANAG 4487**
- **STANAG 4489**
- **STANAG 4491**
- **AOP-7** Ed. 2, 201.02.001
- **MIL-STD-1751A**, Method 1015 & 1024
- **EMTAP**, Manual of Tests, Test No 43 & Test No 44
- **ARMY TB 700-2**, Section 5-3d

BAM Friction Apparatus – porcelain pegs and a plate

BAM Fall Hammer (Impact Tester) – steel cylinders and guide rings

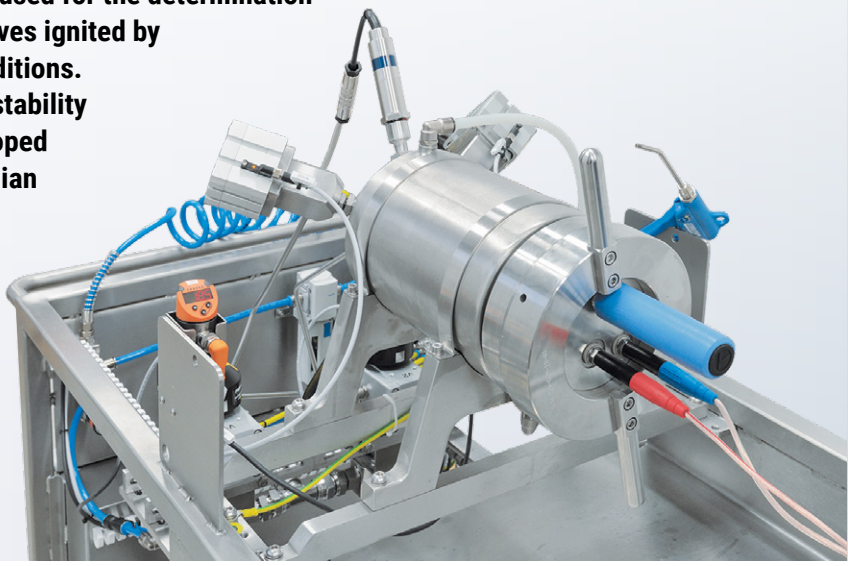
Koenen Steel Shell Tester – test tubes and closing parts

MBP

MINIMUM BURNING PRESSURE APPARATUS

The MBP™ (Minimum Burning Pressure Apparatus) is used for the determination of the minimum burning pressure of emulsion explosives ignited by a hot wire in a closed vessel under high pressure conditions. The MBP is a completely new approach to advanced stability and sensitivity testing of emulsion explosives, developed in cooperation between OZM Research and the Canadian Explosives Research Laboratory (CERL).

The MBP is the very first equipment of its kind on the market and it represents a huge step forward for the safety improvement of ammonium nitrate based explosives. It's a universal, simple-to-use and easy to evaluate solution made durable for both production and scientific experiments.



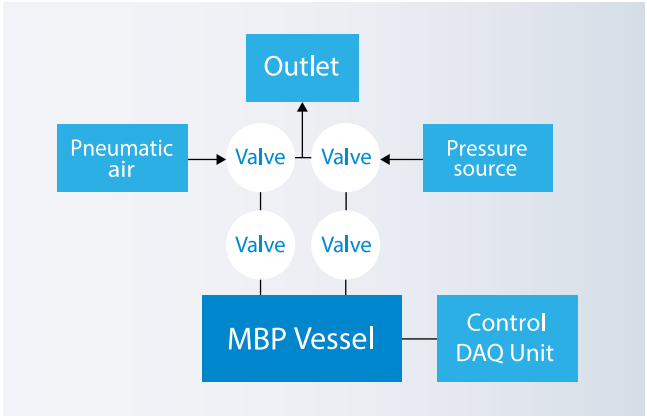
APPLICATIONS

While emulsion explosives are normally quite safe for handling, accidents connected with them are still occurring and conventional methods of stability or sensitivity testing are not representative enough to discover their risky behavior. It has been found that most of the accidents happened when the materials were subjected to elevated pressures and temperatures during their pumping, manufacturing or transport. The determination of the minimum burning pressure has therefore become one of the most important safety characteristics of emulsion explosives.

The **MBP** is primarily designed for testing sensitivity of emulsion explosives during both their development and industrial manufacture. Small-scale tests with **MBP** can provide very important information about the emulsion explosive safe pumping pressure. The **MBP** can also be used for other explosives, which are likely to be subjected to pressure and temperature loads.

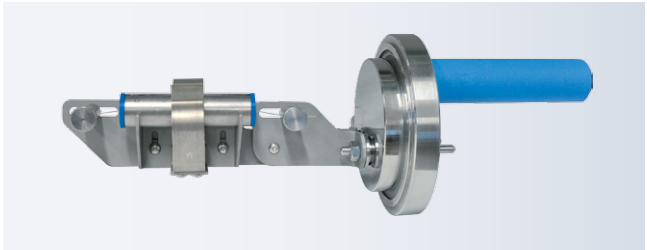
ADVANTAGES & FEATURES

- Certified closed vessel from a noncorrosive material
- Working pressure up to 500 bar (with a remotely controlled pressure manifold)
- Precise constant current power supply for thermal ignition of the sample
- Measurement of time-to-decomposition, terminal pressure of decomposition and decomposition rate
- Easy to handle, heavy duty, one-box design with simple connectivity and user-friendly software for data processing



MBP vessel basic scheme

MBP measurement and control unit



MBP lid with the sample holder

HPA 1500

HIGH PRESSURE AUTOCLAVE

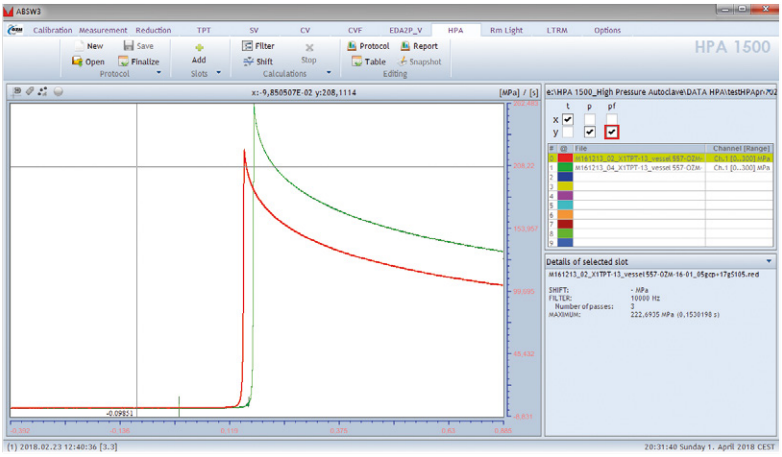
The HPA 1500™ High Pressure Autoclave is a standardized instrument designed to measure a specific energy of energetic chemical substances for their hazard classification according to the UN Recommendations on the Transport of Dangerous Goods.

APPLICATIONS

Compact laboratory instrument containing testing vessel, pressure transducer, a control unit with in-built precise pulse power ignition source, transducer conditioner, data acquisition unit and all-inclusive software.

Determination of specific energy (amount of energy released by the tested substance) is an important parameter for hazard assessment of energetic chemicals for their safe production, handling and transportation in chemical industry.

Obtained results (max. pressure, pressure rise time, burning rate, etc.) usually serve for the safety classification of energetic materials.



HPA software screenshot

ADVANTAGES & FEATURES

- Ignition source with voltage and current feedback generates a precise constant power impulse
- Standardized 96 cm^3 volume stainless steel testing vessel with working pressure up to 2,000 bar
- Test results: pressure vs. time profile, maximum pressure and specific energy
- Two different control units designed for using different pressure transducers
- Simple operation, control, measurement, calibration and data evaluation by **TPT-SW** software

There are two versions of the control unit available:

Version	TPT-MCU	EDAL
Strain-gauge pressure transducer	YES	YES
Dynamic piezoelectric transducer	NO	YES
Number of optional inputs	1	4

COMPLIANCE

- **UN Recommendation on the Transport of Dangerous Goods, Manual of Tests and Criteria** [Test F.5 High Pressure Autoclave]

TPT SERIES

TIME-PRESSURE TEST APPARATUS / TEST FOR OXIDIZING LIQUIDS

The TPT Series™ (Time-Pressure Test Apparatus) is used for the hazard classification of dangerous substances (flammable, oxidizing and energetic materials) according to the UN Recommendations on the Transport of Dangerous Goods. The test is based on ignition of a tested substance in a semi-closed vessel and measurement of the resulting pressure-time profile.

APPLICATIONS

Determination of the burning characteristics (tendency to ignition-to-deflagration transition and its violence) under confinement is an important parameter for hazard assessment of energetic chemicals in production, handling and transportation in chemical and explosives industries. Results obtained by standardized tests (max. pressure and pressure rise time etc.) provide safety information about violence of decomposition. Specific energy determines the amount of mechanical energy released by tested substances.

ADVANTAGES & FEATURES

- Two stainless steel testing vessels containing a set of adapters for different testing procedures are available:
  - / standard **TPT** semi-closed testing vessel with working pressure up to 100 bar
  - / **TPT 3000** semi-closed or closed testing vessel for high pressure testing up to 3,000 bar
- Precise pulse power source for ignition by an electric fuse or a hot wire
- Strain-gauge pressure sensors with a tailored data acquisition system
- Test results: pressure vs. time profile, maximum pressure and specific energy
- Simple operation, control, measurement, calibration and data evaluation by **TPT-SW** software

There are two versions of **TPT Series** vessels available:

Version	(Standard) TPT vessel	TPT 3000 vessel
Maximum working pressure	100 bar	3,000 bar
Vessel design	Semi-closed	Semi-closed or closed
Testing according to UN/EU standards	YES	YES
Determination of specific energy	NO	YES

Standard TPT vessel parts

TPT 3000 vessel parts: **LP** up to 100 Bar • **HP** up to 3,000 Bar

STABILITY TESTING

Explosive materials are energetic substances with inherent chemical or thermal instability, which can be detected after long-term storage even at normal temperatures. The instability is accelerated significantly at higher temperatures or by incompatibility reactions with contact materials and can lead to devastating explosions of stored explosive materials or ammunition caused by their self-ignition.

This is why it is critically important to test chemical and thermal stability of explosive materials with reliable and representative methods and instrumentation in all testing programs, but especially in qualification for service, in-service ammunition surveillance and ammunition demilitarization.

STABIL® VI

MODERNIZED VACUUM STABILITY TEST APPARATUS

The STABIL® (Modernized Vacuum Stability Tester) is used for the determination of the chemical stability and compatibility (reactivity) of energetic materials (especially propellants). The STABIL VI is a fully instrumental tester equipped with sensitive electronic pressure transducers, communication with PC (for direct control), continuous data acquisition, analysis and archiving.

The unique design of the STABIL VI completely replaces old mercury-containing apparatuses with non-toxic, safe and easy-to-operate precise instrumentation. Electronic pressure transducers allow for continuous measurement of the volume of decomposition gases evolved during the test. OZM Research continues its long and proud tradition of the electronic vacuum stability testers – the first generation of STABIL instrument was developed over 40 years ago in the Czech Republic. Today's STABIL VI is the latest generation of this long innovation process and raises the standard of excellence in the VST testing equipment worldwide.

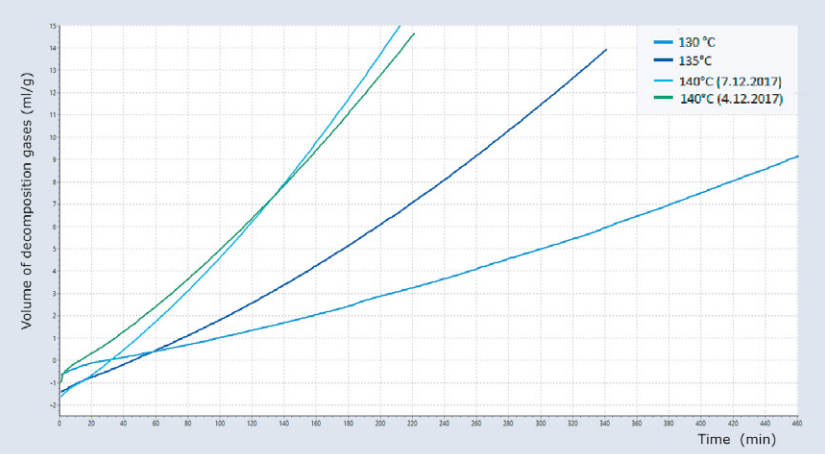
APPLICATIONS

The **STABIL VI** is frequently used for the determination of the chemical stability and compatibility of energetic materials and for quality tests of energetic ingredients. The test is able to discover chemical instability of energetic materials caused by the presence of destabilizing impurities, incompatibility with surrounding materials, or aging, with high sensitivity, precision and reproducibility.

The **STABIL VI** finds its broad application in qualification, surveillance, manufacture, quality control and research and development of a wide range of energetic materials.

ADVANTAGES & FEATURES

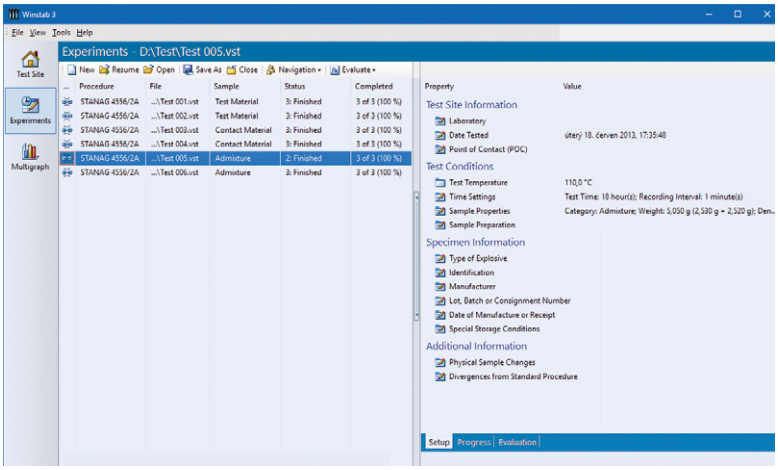
- Lift for automatic inserting and removing the test tubes
- 1–24 independent sample measurements may be conducted simultaneously (up to 12 samples in each heating block)
- Continuous Pressure-Time Record and automatic calculation for Volume-Time Dependence
- Automatic temperature calibration
- Rate of pressure rise and overpressure inside the test tubes are monitored by the software as a part of the alarm functions
- Independent alarm circuit for temperature monitoring (to avoid overheating)
- High precision and long term accuracy of pressure measurement
- Measurements at two different temperatures may be conducted simultaneously in two heating blocks
- Determination of the gas evolution rate or total volume of gases evolved by sample decomposition
- The **STABIL VI** tester can also be used with minor modifications for other customer defined tests, such as long-term (weeks, months) stability tests at lower temperatures.



Volume of decomposition gases at different temperatures

COMPLIANCE

- **STANAG 4022/4**
- **STANAG 4023**
- **STANAG 4147**
- **STANAG 4230**
- **STANAG 4284**
- **STANAG 4556**
- **STANAG 4566**



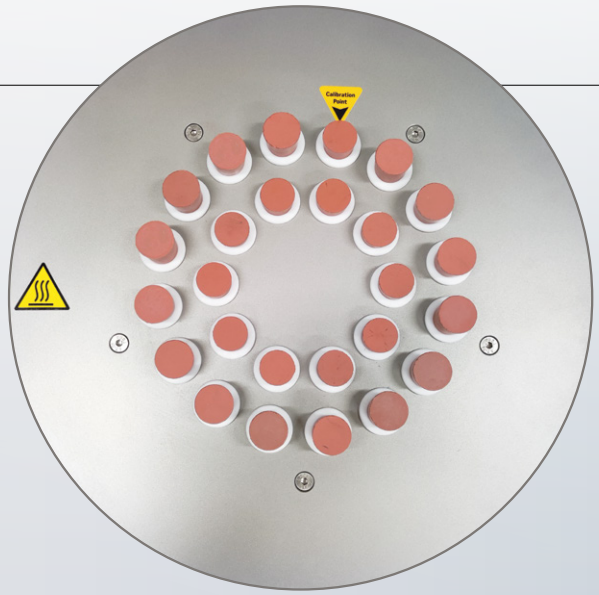
WINSTAB software – test conditions of test and sample parameters

STABIL – pressure transducers during experiment

WINSTAB software – comparison of different tests

HEATING BLOCKS

FOR DETERMINATION OF THERMAL STABILITY



Thermal and chemical stability is crucial for the safe manufacture, storage, transportation and use of energetic materials. OZM Research provides a comprehensive selection of instruments designed to accurately determine the thermal and chemical stability for all types of energetic materials. Whether concerning quality control testing, hazardous materials evaluation, or in-service surveillance, OZM Research offers the most reliable and highest quality thermal stability testing equipment.

APPLICATIONS

Traditional tests for the determination of the thermal stability of energetic materials (mainly propellants) are based on heating samples at elevated temperatures and detecting their reactive decomposition products (NO_x). Detection can be based on the visual identification of colored gases above the sample (Heat Storage Test at 100 °C), a color change of indicator papers (Abel Test, Methyl Violet Test), the quantitative determination of the amount of gaseous decomposition products by analysis of the acidity of the water extract (Bergmann-Junk Test), or the determination of weight loss (Holland Test). Heating samples at elevated temperatures is also used to determine the shelf life of propellants using artificial ageing according to STANAG 4117, AOP-48 (HBA heating blocks).

All testing devices for thermal stability consist of temperature controllers and heating blocks (each containing from 4 to 45 appropriately sized holder holes). Customized glass test tubes are supplied with each instrument.

ADVANTAGES & FEATURES

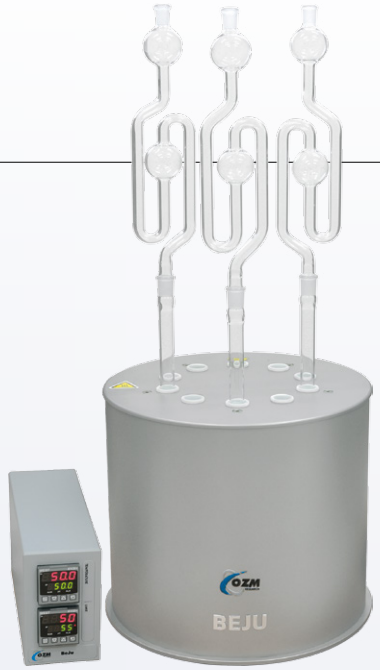
- Customized heating blocks available upon request
- High precision and accuracy of the heating block temperature
- Fast operation time and proven testing procedures
- Independent alarm circuit (limit controller) for additional temperature control

Typical experiment conditions

Heating Block	Temperature	Sample Mass	Test Duration	Observed Parameter
BEJU	120 and 132 °C	1–5 g	2–5 hours	Amount of NO_x
ABT	65–85 °C	1 g	max 60 min	Color change of indicator paper
MVT	120 and 134.5 °C	2.5 g	max 30 min	Color change of indicator paper
CH 100	100 °C	10 g	max 7 days	Appearance of NO_x
HBA	50–90 °C	20 g	120 days	N/A
HT	90–110 °C	4 g	3–7 days	Amount of decomposition gases

BEJU

BERGMANN-JUNK TESTER



The instrument for the determination of thermal stability according to the Bergmann-Junk procedure at 120 and 132 °C is designed for the evaluation of the thermal stability of nitrocellulose, smokeless powders, or propellants. This test is based on the quantitative determination of the amount of gaseous products evolved during the thermal decomposition of the sample in a glass adapter filled with water. The amount of gaseous products is estimated by volumetric analysis of the acidity of the water extract.

COMPLIANCE

- **MIL-DTL-244C**
- **STANAG 4178**
- **TL 1376-0589** and **TL 1376-0600**
- **UK M28/89**

ABT

ABEL HEAT TESTER

MVT

METHYL VIOLET TESTER

The **ABT** (Abel Heat Test) and **MVT** (Methyl Violet Test) instruments are designed to evaluate the thermal stability of nitrocellulose, nitroglycerine and nitroglycol using the Abel Test and Methyl Violet Test procedures. Both instruments are also well suited for testing propellant stability. These tests are based on the fact that nitrate esters decompose to produce NO_2, and the rate of decomposition increases rapidly at elevated temperatures, leading to the production of “red fumes.” The presence of gaseous decomposition products is determined by a color change of the Iodide-Starch (ABT) or Methyl Violet indicator paper. The result of these tests is the time period from inserting a sample into a preheated heating block to the change of color of the indicator paper.

ABT COMPLIANCE

- **AOP 7**
- **DEFSTAN 13-189/1**
- **MIL-DTL-244B**
- **STANAG 4178**

MVT COMPLIANCE

- **MIL-DTL-244C**
- **MIL-STD-286C**
- **STANAG 4118**

CH 100

HEAT STORAGE TEST AT 100 °C

The **CH 100** instrument is specifically designed to determine the thermal stability of smokeless powders and propellants through long-term isothermal heating. Thermal stability is evaluated by visually inspecting the appearance of the red fumes, which indicates the presence of decomposition gases (oxides of nitrogen).

HBA

HEATING BLOCKS FOR ARTIFICIAL AGEING

During the lifetime of an explosive sample, exothermal decomposition occurs. The rate of this exothermal reaction is proportional to temperature. Under normal conditions, the rate of decomposition is small (the lifetime of propellants or explosives is usually many years). Therefore, accelerated ageing is used to predict the lifetime of an explosive sample. The simplest method of accelerated ageing is long-time storage of explosive samples at elevated temperatures (usually 50 °C to 90 °C). During the time of the test, changes in sensitivity, stability, chemical composition, ballistic or mechanical properties are assessed.

COMPLIANCE

- **AOP 48**
- **STANAG 4117, 4527, 4541, 4620**

HT

HOLLAND TEST APPARATUS

The **HT**™ (Holland Test or Dutch Weight Loss Test) apparatus is used to determine the thermal stability of energetic materials by measuring the mass loss of a sample during isothermal heating, which is caused by the decomposition of the solid sample into gaseous products. The sample is subjected to a long-term (3 days or more) isothermal heating and its weight is monitored throughout the testing period using external balances. The weight loss percentage versus time is reported.

COMPLIANCE

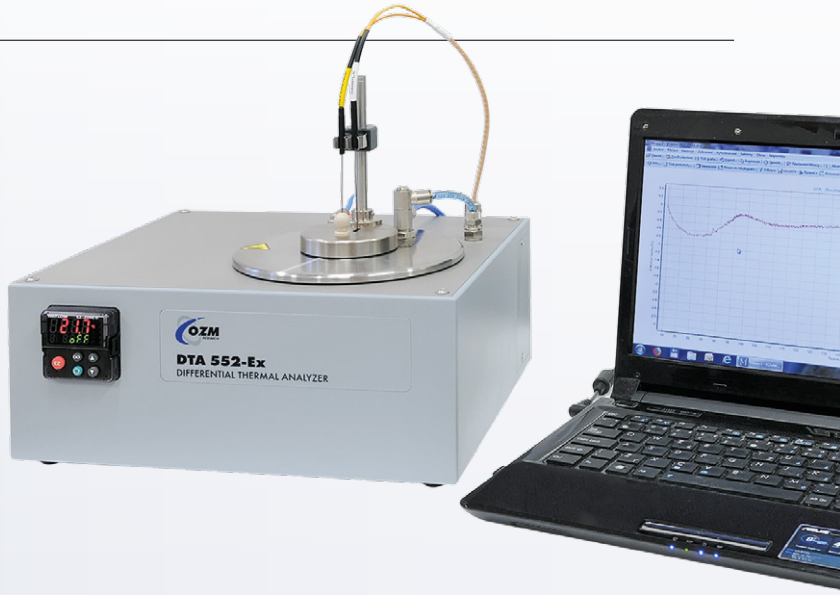
- **TL 1376-0600**

DTA 552-Ex

DIFFERENTIAL THERMAL ANALYZER

The DTA 552-Ex™ (Differential Thermal Analyzer) was developed specifically for the evaluation of thermal stability, purity (melting point), compatibility and decomposition parameters of all types of energetic materials including primary explosives or other hazardous exothermic substances.

The robust design of the DTA 552-Ex makes it the ideal instrument for the characterization of explosive materials, which explosive decomposition would damage or destroy conventional thermal analyzers.



APPLICATIONS

The **DTA 552-Ex** detects and analyses thermal changes (melting, polymorph transformation, evaporation and thermal decomposition) occurring in the sample and allows for the evaluation of the thermal stability, purity, compatibility and the thermal decomposition parameters of all types of energetic materials.

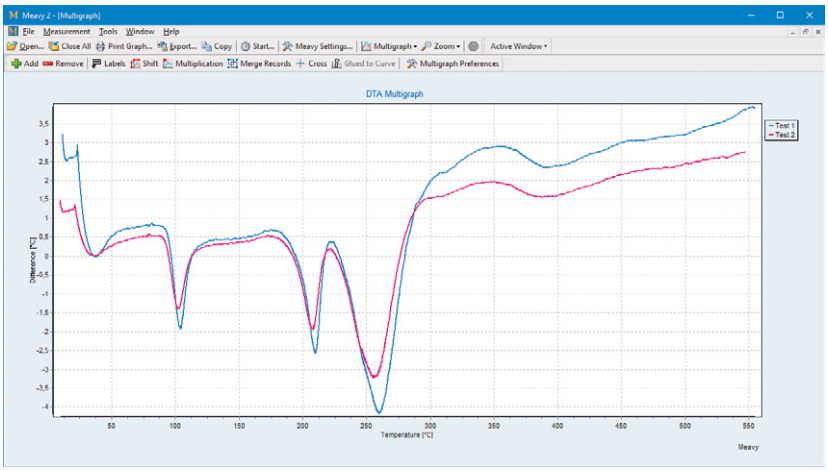
The **DTA 552-Ex** is an essential instrument for quality control of energetic materials or raw materials, characterization and qualification of new compounds, in-service surveillance, research and development and many other testing programs.

ADVANTAGES & FEATURES

- Larger quantities (up to several hundred milligrams) provide a truly representative sample for analysis
- Variability of applicable substance forms (paste, liquid, foam and corrosive)
- High sensitivity – direct contact of the thermocouple with the sample
- User-friendly software for data acquisition, analysis and archiving
- Low costs of investment and operation

COMPLIANCE

- **STANAG 4515**



MEAVY software – evaluation of results

DTA 552-Ex – detail of the furnace

AET 402

EXPLOSION TEMPERATURE APPARATUS

The AET 402™ (Explosion Temperature Apparatus) is used for the determination of the explosion (ignition) temperature of energetic materials submitted to heating.

The AET 402 instrument is equipped with sensors and an automatic data acquisition unit for the automatic registering the explosion effects. This unique feature helps the operator to fully replace visual observation and provides exact testing results free of human errors.

APPLICATIONS

The **AET 402** is designed for the determination of the explosion (ignition) temperature at constant heating rates or a time-to explosion in isothermal (constant temperature) mode.

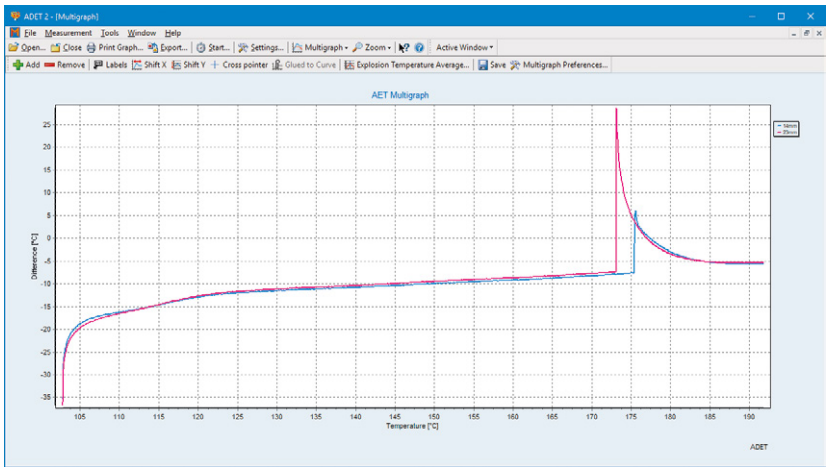
The **AET 402** is the most frequently used as a quality-control instrument in the manufacture of explosives, pyrotechnic mixtures and propellants.

ADVANTAGES & FEATURES

- Robust design capable of withstanding an explosion of up to several hundred milligrams of explosives
- Recognizes the decomposition regardless if it is accompanied by sound or light emission unlike classic instruments
- User-friendly software for data acquisition, analysis and archiving
- Low costs of investment and operation

COMPLIANCE

- **STANAG 4491**



ADET software – evaluation of results

AET 402 – detail of the furnace

EXPLOSIVE PERFORMANCE TESTING

Performance properties of high explosives can be measured by a variety of instrumental methods, ranging from laboratory tests such as explosion heat or detonation heat determination, underwater blast test or experiments in laboratory detonation chambers (shock wave pressure, impulse, heat flow, detonation velocity), up to the large-scale field tests.

OZM Research specializes in high-speed optical methods for analysis of detonation processes allowing precise measurements of detonation wave speed and curvature, shock wave propagation or charge casing expansion. VeloreX PDV, our new Photonic Doppler Velocimeter, is capable of measuring speeds of multiple flying objects up to 10 km/s range (in Flyer Plate Test, Cylinder Expansion Test or Initial fragment velocity tests).

The small-scale detonation experiments (up to 2 kg TNT load) can be safely executed directly in explosives laboratories themselves using laboratory or industrial detonation chambers.

R&D of new explosive materials can be effectively assisted by EXPLO5 thermochemical program, carrying out sophisticated calculations of explosion parameters of new substances or mixtures.

BCA® 500

HIGH PRESSURE BOMB CALORIMETER

UPGRADE

The BCA® 500 is the only single-instrument solution for the combustion (deflagration) calorimetry of energetic materials on the market. It offers superb resolution, electronic calibration, high pressure measurement, metrological traceability, semi-automatic operation, durable construction, easy to use concept and one-box design with an integrated water cooler.

design by Jan ERMIS

APPLICATIONS

The **BCA 500** is well suited for the combustion heat characterization needed for further performance calculations of high explosives or propellants in their research, development, manufacture and in-service surveillance and as well can be used for performance characterization of various fuels (coal, wood etc.).

The **BCA 500**'s precision and performance allow it to be used in quality control systems and in research and development applications with the highest criterion. Typically, coal mines, power plants and explosive production plants find the **BCA 500** indispensable. The tailored design of the **BCA 500**'s accessories and consumables provide an excellent solution for any application especially in the industries of fuels and energetic materials; however, please note the **BCA 500** is not designed for the testing of materials in a detonation regime.

ADVANTAGES & FEATURES

- Superb resolution of temperature measurement system
- Optional electronic calibration system
- Results reproducibility as low as 0.1 %
- The **BCA 500** needs no continuous water supply – all process water is stored inside inner tanks
- Two tanks allow for non-stop testing thereby reducing the operation time
- Advanced water management with integrated chillers provides precise dosing and conditioning
- Easy to operate interface with LCD touch screen
- Fully automated data acquisition, evaluation and management
- Intuitive operation with no special personnel requirements

COMPLIANCE

- **AS 1038.5**
- **ASTM D240**
- **ASTM D4809**
- **ASTM D5468**
- **ASTM D5865**
- **ASTM E711**
- **CSN EN 14918**
- **DIN 51 900**
- **IS 1350-2**
- **ISO 1928**
- **JIS M 8814**
- **MIL-STD-286C**

BCA 500 EX and DC bombs for low and high pressure combustion respectively

DCA 25

DETONATION CALORIMETER

The DCA 25™ is a detonation isoperibolical calorimeter which is designed and made by OZM Research for the determination of detonation heat of all kinds of explosives. In addition, combustion and/or explosion heat can be analyzed as well. The DCA instruments offer superb precision, semi-automatic operation, durable construction, easy to use concept and a one-box design with an integrated water cooler and a bomb manipulator.

APPLICATIONS

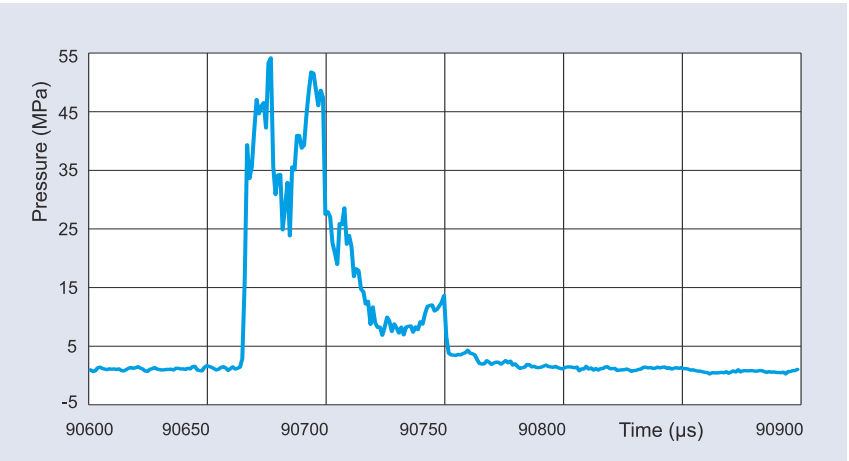
The **DCA 25** (4.7 L volume, max 25 g of TNT equivalency) is well suited for the characterization of performance properties of high explosives or propellants in their research, development, manufacture and in-service surveillance.

ADVANTAGES & FEATURES

- Superb resolution of thermometers: 0.00001 K
- Results reproducibility as low as 0.2 %
- Water supply (all process water is stored inside inner tanks)
- Two tanks allow for non-stop testing thereby reducing the operation time
- Advanced water management with integrated chillers provides precise dosing and conditioning
- Easy to operate interface with LCD touch screen, wireless keyboard and mouse
- Fully automated data acquisition, evaluation and management with remote access features
- Built-in dynamic pressure sensors upon request
- High strength stainless steel detonation chamber for testing in vacuum, air, nitrogen, argon, oxygen etc.
- Built-in bomb manipulator and detachable cart for easy positioning

COMPLIANCE

- **MIL-STD-286C**



High frequency pressure record

DCA 25 bomb detail

VOD 815

VELOCITY OF DETONATION TESTER

The VOD 815™ is a portable instrument created for the measurement of the detonation velocity of energetic materials using fiber optic probes.

The VOD 815 is equipped with 8 passive optical channels, which can handle up to eight probes to measure velocity at seven intervals. The measurement preparation time is less than 10 minutes and the result can be viewed immediately. The use of fiber optic probes principally provides full resistance against stray currents and electro-magnetic disturbances, which allows the instrument to be safely used together with other instruments.

APPLICATIONS

The **VOD 815** is primarily designed for quality control in explosives manufacturing and mining industries, military explosives surveillance and education in the field of energetic materials. In these cases, its simplicity of operation and results evaluation are highly appreciated.

Typical examples of tested samples are:

- Unconfined pressed, plastic bonded or cartridged explosives
- Liquid or gaseous explosives confined in plastic or metallic tubes
- Gaseous explosive mixtures
- Industrial bulk or cartridged explosives in boreholes
- Shaped charge (jet velocity)

ADVANTAGES & FEATURES

- 8 passive fiber optic probes
- Simple operation and data acquisition
- Immune to stray currents and EM disturbances
- Battery powered
- Shockproof protective case

COMPLIANCE

- **EN 13630-11** Explosives for Civil Uses – Detonating cords and safety fuses - Part 11: Determination of velocity of detonation of detonating cords
- **EN 13631-14** Explosives for Civil Uses – High explosives, Part 14: Determination of Velocity of Detonation

VOD 815 in a shockproof case

Measurement setup for a confined plastic explosive

OPTIMEX 8

OPTICAL ANALYZER OF EXPLOSIVE PROCESSES

The OPTIMEX™ 8 a multipurpose portable instrument designed for the measurement of detonation velocity and other parameters using 8 fiber optic probes with the continuous recording of light signal intensity.

The OPTIMEX 8 is the next generation of the VOD 815 tester with a completely redesigned optoelectronic acquisition system and advanced data evaluation features based on the extensive research of explosives' light output. The instrument retains all abilities of its predecessor while offering several others.

APPLICATIONS

The **OPTIMEX 8** is primarily designed for measurements of detonation velocity of energetic materials in research, industrial, military, educational or engineering applications.

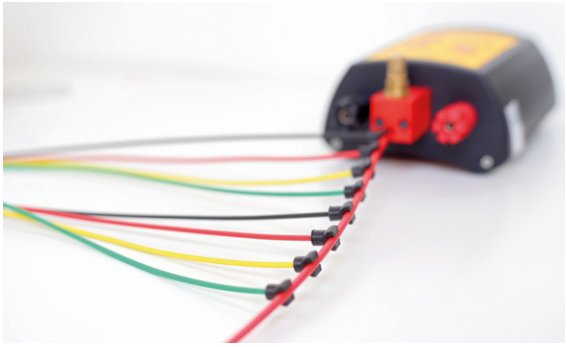
The instrument records full light intensity-time profiles at specific places within an explosive charge which allows to track detonation or shock waves. Analysis of light intensity profiles makes evaluation of such signals robust and reliable for all existing samples including non-ideal explosives. Explosive's translucency, low light emissivity, afterburning, etc. no longer spoil the measurement results.

Tasks for **OPTIMEX 8** may include determination of:

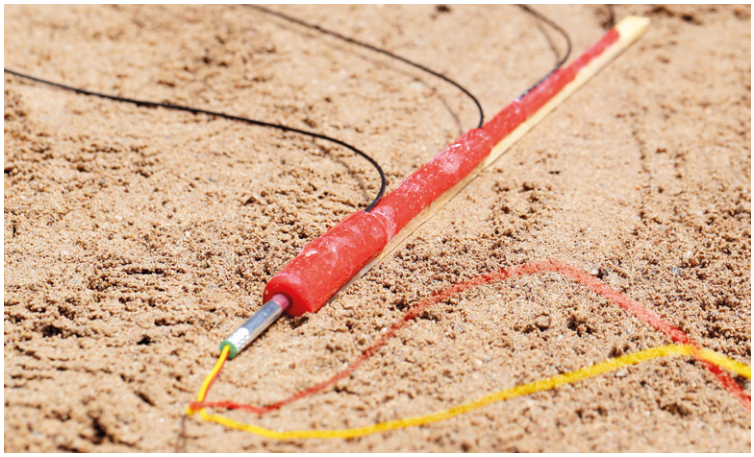
- Detonation velocity, a basic parameter of all explosives
- Detonation wave curvature, a measure of the ideality of detonation
- Shock velocities in inert materials, useful for the estimation of detonation pressure

ADVANTAGES & FEATURES

- 8 passive optical probes (either plastic or glass fibers)
- Light intensity-time profiles recording
- Immune to stray currents and EM disturbances
- Controlled via tablet PC
- Automated data evaluation routines
- Battery powered, 8 hours of operation



Deflagration to detonation transition tracking in a shocktube



Detonation velocity measurement using Perforated Fiber Probe

COMPLIANCE

- **EN 13630-11** Explosives for Civil Uses – Detonating cords and safety fuses - Part 11: Determination of velocity of detonation of detonating cords
- **EN 13631-14** Explosives for Civil Uses – High explosives, Part 14: Determination of Velocity of Detonation
- **EN 13763-23** Explosives for Civil Uses – Detonators and relays – Part 23: Determination of the shock-wave velocity of shock tube

OPTIMEX 64

ADVANCED OPTICAL ANALYZER OF EXPLOSIVE PROCESSES

The OPTIMEX™ 64 is an advanced scientific instrument used for the measurement of detonation velocity (and other parameters of detonation) and shock waves using multiple fiber optic probes along with the continuous recording of light signal intensity.

The OPTIMEX 64 is an extended version of OPTIMEX 8 with the ability to accommodate even more optical measurement channels. The channel count can be user defined from 8 to up to 64. With such a high number of fiber optic probes, the instrument's capabilities resemble those of a high-speed streak camera. The fiber optic probes principally provide full resistance against humidity and electromagnetic disturbances allowing the instrument to be combined with other instrumentation.

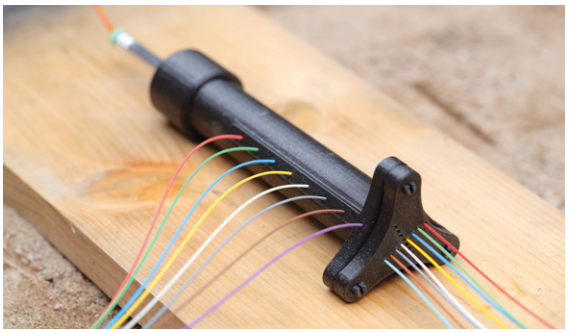
APPLICATIONS

The **OPTIMEX 64** has all the application capabilities of the **OPTIMEX 8** plus many others. It can handle measurements of detonation velocity of energetic materials in advanced research, industrial, military, educational or engineering applications.

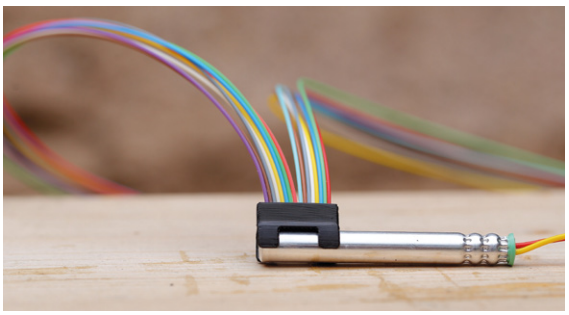
The instrument records full light intensity-time profiles at specific places within an explosive charge which allows to track detonation or shock waves. Analysis of light intensity profiles makes evaluation of such signals robust and reliable for all existing samples including highly non-ideal explosives. Explosive's translucency, low light emissivity, afterburning, etc. will no longer spoil the measurement results.

Tasks for **OPTIMEX 64** may include determination of:

- Detonation velocity, a basic parameter of all explosives
- Detonation wave curvature, a measure of an explosion's ideality
- Shock velocities in inert materials, useful for the estimation of Chapman-Jouguet detonation pressure
- Shock or detonation wave tracking in complex explosive initiation trains
- Basic cylinder expansion testing where the wall velocity is a measure of explosive strength (a less precise and less expensive alternative to the VeloreX PDV)



Simultaneous detonation velocity and shock curvature measurement



Detonation velocity measurement of a blasting cap

ADVANTAGES & FEATURES

- Up to 64 passive optical probes according to the customer's requirements (plastic or glass fibers or a combination)
- Light intensity-time profiles recording
- Immune to stray currents and EM disturbances
- Touch screen LCD display
- Automated data evaluation routines

COMPLIANCE

- **EN 13630-11** Explosives for Civil Uses – Detonating cords and safety fuses - Part 11: Determination of velocity of detonation of detonating cords
- **EN 13631-14** Explosives for Civil Uses – High explosives, Part 14: Determination of Velocity of Detonation
- **EN 13763-23** Explosives for Civil Uses – Detonators and relays – Part 23: Determination of the shock-wave velocity of shock tube

VELOREX PDV

PHOTONIC DOPPLER VELOCIMETER

The VeloreX PDV™ is an advanced instrument used for the measurement of the continuous velocity-time profiles of high speed moving objects. It can be used for the determination of various detonation properties of energetic materials as well as for any other tasks where high precision in velocity or displacement measurements are crucial.

The VeloreX PDV is capable of tracking target velocities in order of kilometers per second with nanosecond time resolution. The measurement procedure is simple and robust with practically no constraints regarding the quality of the target surface.

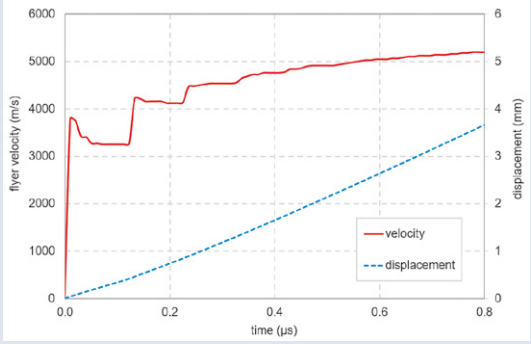
APPLICATIONS

The measurement of the velocity profiles of explosively accelerated materials can be used for determination of key properties of high explosives. Compared to the piezoelectric pin or high-speed streak camera instrumentation, the **VeloreX PDV** offers dramatically increased time resolution and velocity accuracy.

Example applications of the **VeloreX PDV** include:

- Flyer plate test to determine detonation pressure of explosives
- Cylinder expansion test to characterize expansion of detonation products
- Deflection and spall velocity tracking in blast loaded constructions
- Projectile velocity measurements in shock physics experiments
- Explosion welding optimization by a cladder plate velocity measurement
- Observing vibrations in engineering structures
- Detonator testing

Flyer plate test setup



Initial part of the flyer plate velocity profile

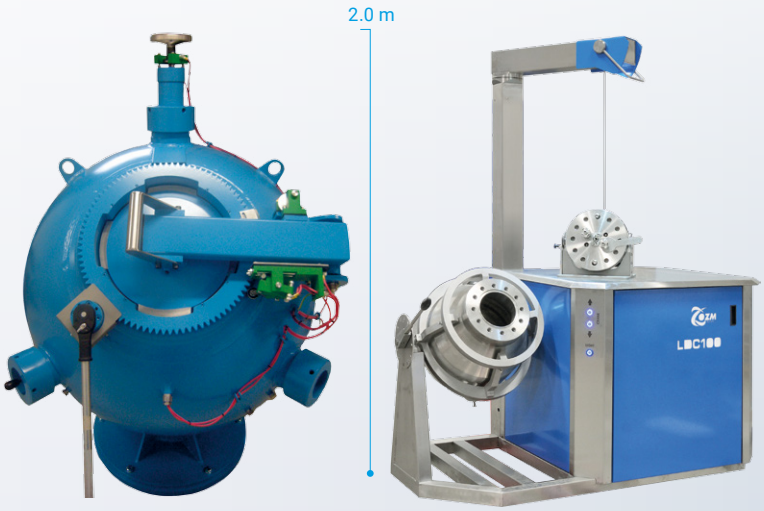
ADVANTAGES & FEATURES

- Up to 4 measurement channels
- Maximum velocity limit tailored according to the customer's needs (up to 10 km/s)
- Various probes available for a wide range of applications
- Advanced trigger options
- Eye safety thanks to all-fiber design
- Simple operation and evaluation

LABORATORY DETONATION CHAMBERS

Laboratory detonation chambers allow users to safely carry out detonation experiments of up to 250 g TNT equivalent directly inside explosives laboratories without any excessive noise loading.

They can be used for scientific and forensic investigations, research, development, testing or quality control in the area of energetic materials, confined explosions and related applications such as the explosive forming of metals or the safe and environmentally friendly disposal of explosive wastes. The service life of the detonation chambers can reach 10,000s shots.



KV 250M5 LDC 100

ADVANTAGES & FEATURES

- Multiple ports for the installation of pressure or temperature sensors for the characterization of confined explosions
- Optical cable ports for investigation of the detonation processes by the **VOD 815**, the **OPTIMEX 64** or the **VeloreX PDV**
- Safe execution of brisance, cook-off, large-scale **ESD** and large-scale stability tests
- Gas-tight valves enable the creation of different gas atmospheres in the chambers and the sampling of the post-explosion gases
- Fast ventilation of the chamber interior with compressed air after a shot, ready within minutes for another experiment
- Safety interlocks prevent the premature electric firing of the explosive charges
- Periodically proof-tested on 125 % nominal capacity, produced for more than 15 years with no safety incident or accident reported
- Very little maintenance work and costs

MODELS

- **LDC 100** is a a stainless steel vessel closed by a screw-mounted lid (the explosive charge hangs in the chamber lid) with a maximum capacity of 100 g TNT eq. Due to its weight (approx. 300 kg), the vessel can be embedded in a special working stand with an electric crane manipulator, rotating fixture for easier cleaning and tool shelves for accessories.
- **KV 250M5** is a heavy-duty steel detonation chamber with a maximum capacity of 250 g TNT eq. and a large internal space for testing setups, equipped with an easily accessible working table for positioning the explosive charge, a manually operated bayonet lock for the quick closing and opening of the lid, input and output valves, 10 ports for optical or electrical measuring cables, as well as 4 symmetrically positioned optical windows for the installation of other sensors or high-speed cameras.

Product name	LDC 100	KV 250M5
Capacity [g TNT]	100	250
Working table dimensions [mm]	–	Ø 300
Weight [kg]	600	2 300
Total dimensions L × W × H [m]	1.0 × 2.0 × 2.0	1.4 × 1.4 × 2.0

KV 2S

SCIENTIFIC DETONATION CHAMBER

KV 2S is a universal detonation chamber applicable for a wide portfolio of operations ranging from scientific laboratory experiments to heavy-duty industrial processes.

KV 2S is an automated machinery designed to withstand repeated detonations of up to 2 kg TNT as a part of a manufacturing process, quality control tests or scientific research programs.

ADVANTAGES & FEATURES

- Compared to the simpler manually-operated laboratory detonation chambers, this industrial-type detonation chamber is equipped with hydraulic-driven moving parts and a control panel for fully automatic remote operation.
- The chamber is opened and closed by a back-folding cupola exposing a large working space, equipped with four optical windows and multiple measuring ports for scientific instrumentation, along with additional anti-fragment protection.
- During dozens of years in operation in very demanding conditions, **KV 2S** detonation chambers have demonstrated long service life (10,000s detonations), high reliability, safety and negligible operating costs.

Control panel of the detonation chamber

APPLICATIONS

- Scientific research, development and testing of explosives and ordnance
- Scientific investigations of confined explosion effects
- Quality control in the manufacture of explosive materials
- Industrial explosive forming of metals (hardening, pressing, cutting, welding)
- Forensic investigation of improvised explosive devices (IED)
- Safe disposal of explosives, initiators and small ammunition elements
- Safe execution of large-scale sensitivity or stability tests
- Safe storage of unstable explosive substances in explosives laboratories, etc.

Product name	KV 2S
Capacity [g TNT]	2 000
Working table dimensions [mm]	Ø 700
Weight [ton]	11
Total dimensions L × W × H [m]	2.9 × 1.8 × 2.8

EXPLO5

THERMOCHEMICAL COMPUTER CODE

The EXPLO5™ is a multipurpose tool able to predict the energetic properties of single compounds or mixtures, the explosibility of possibly dangerous substances, the performance indicators of ideal and non-ideal explosives and propellants and the pyrotechnic compositions on a basis of chemical formula, heat of formation, and density. The code includes a large database of reactants and products.

Current version: **6.06**

EXPLO5 SOFTWARE IS DEVELOPED BY DR. MUHAMED SUCESKA

APPLICATIONS

The **EXPLO5** may be used for a wide range of applications including safety management (within chemical/pharmaceutical labs), the numerical modelling of energetic materials, the formulation of new energetic compounds, and the optimization of industrial blasting operations.

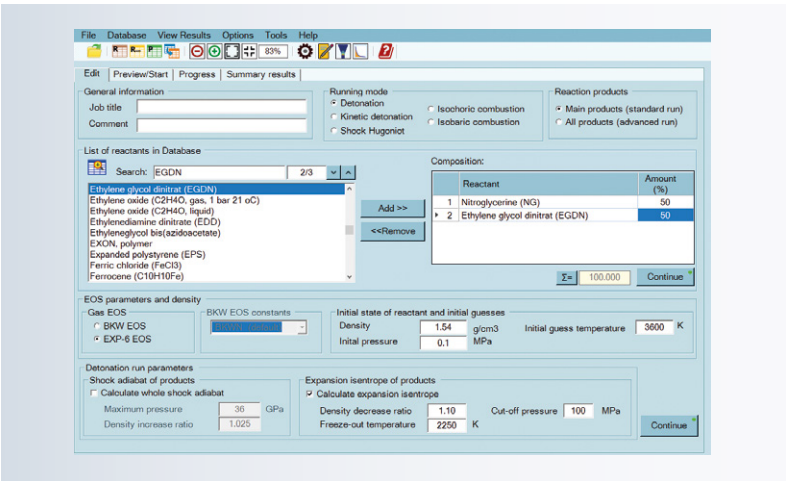
Typical users of the code are synthetic chemists, risk assessment managers, blasting engineers, researchers and any other specialists in the fields of energetic materials.

ADVANTAGES & FEATURES

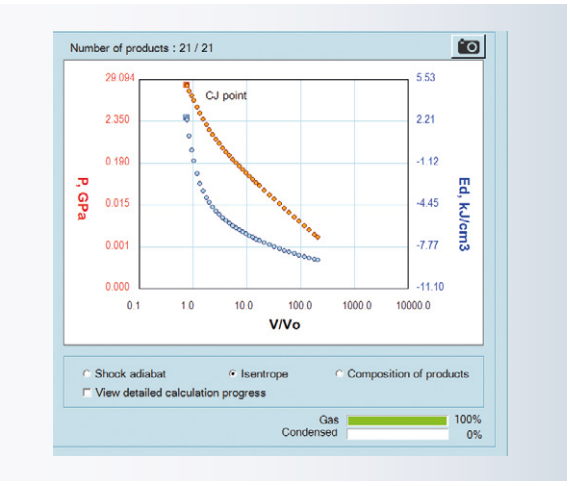
- Calculation of combustion and detonation processes
- Over 650 reactants (explosives and components) and 1 040 products in the database
- 48 different chemical elements available
- Non-ideal detonation calculations
- User training via live teleconference
- NEW Gurney tool enables metal acceleration calculations

COMPLIANCE

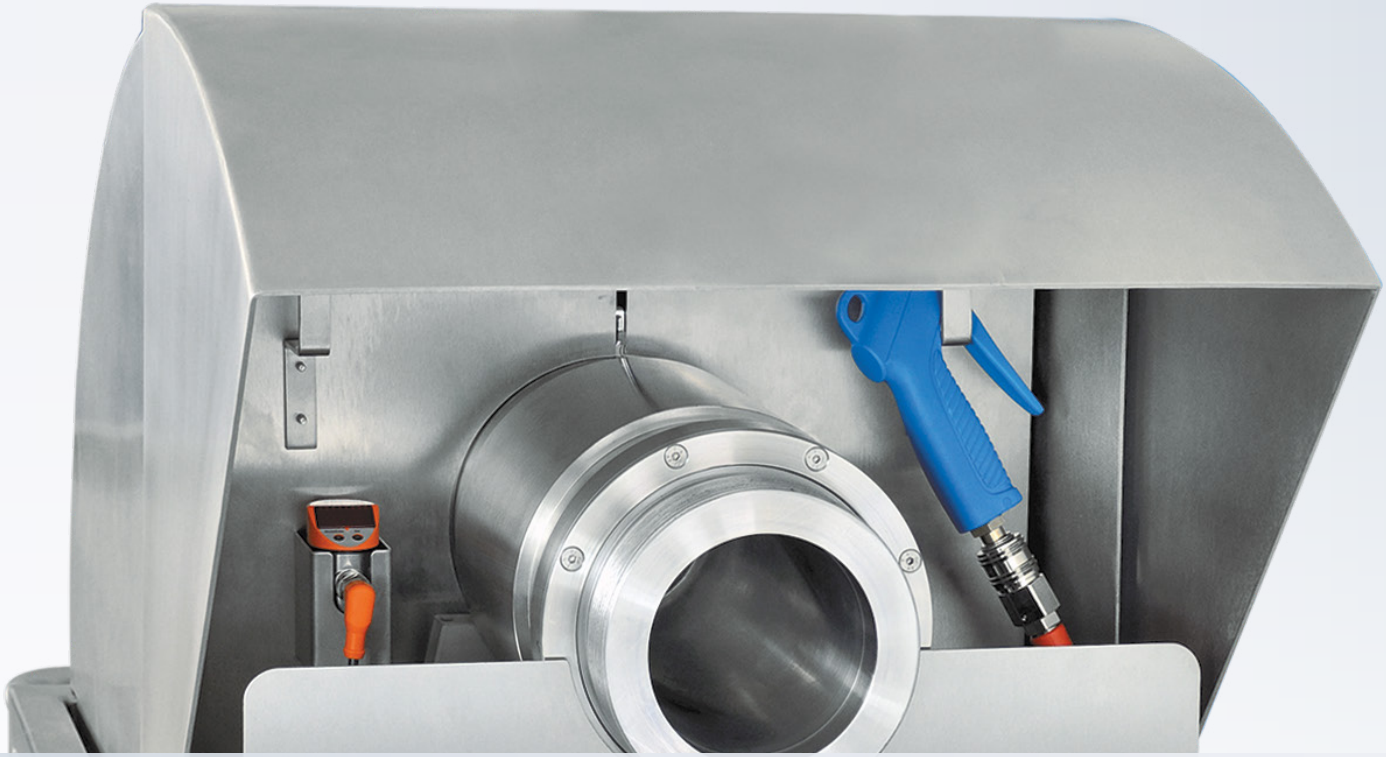
- **EN 13631-15:2005** Explosives for Civil Uses – High explosives, Part 15: Calculation of thermodynamic properties



Input window of the EXPLO5



Calculation of the detonation products expansion



INTERIOR BALLISTIC AND ROCKET PROPELLANTS TESTING

Measurement of performance properties of pyrotechnic mixtures, gun and rocket propellants, as well as related explosive devices (EED, CAD, PAD) is a very important and sensitive indicator of any irregularities in their manufacture, as well as of their excessive ageing during long-term storage. Deteriorated performance properties can lead not only to their failure to operate (duds) or to negatively influenced ballistic behavior but also to devastating system failures (rocket motor or gun barrel explosions).

Explosion heat measurement is a method very sensitively revealing chemical changes in the propellants and pyrotechnics influencing their ballistic performance. Pressure-time burning profiles of gun propellants, pyrotechnic mixtures, as well as explosive devices, are best to be analyzed by the closed vessel tests. Rocket propellants can be tested very extensively using small-scale advanced burning rate tests and rocket motor tests.

Performance parameters of assembled Electro-Explosive Devices (EED), Cartridge-Actuated Devices (CAD) and Propellant-Actuated Devices (PAD) can be analyzed using a precision current source with a defined ignition impulse, combined with customized closed vessels for measuring pressure-time profiles or with a measurement of pressure and thrust profiles.

TSV SERIES

TESTING CLOSED VESSELS

The TSV Series™ Testing Closed Vessels (Manometric Bombs) are designed for the measurement of burning behavior (pressure-time profiles) and ballistic parameters (quickness and the specific energy) of gun, rocket or airbag propellants, pyrotechnic mixtures and other energetic substances or small explosive devices (igniters, squibs).

TSV 40 (40 cm³)

APPLICATIONS

The **TSV Series** Testing Closed Vessels are used for measuring the burning pressure profile of not only energetic materials (gun, rocket or airbag propellants, booster and gas-generating pyrotechnics or other substances, etc.) but also igniters as electrical squibs or for other special testing purposes. Data obtained from the measurements in closed vessels are used for development of new products or their quality control during manufacture or in-service surveillance.

Compared to larger test closed vessels, such as **RB series**, the **TSV Series** is a convenient low-cost solution for non-frequent testing in laboratories, for testing fast burning samples (small caliber gun propellants and ignition powders) or for testing samples creating highly corrosive residues.

ADVANTAGES & FEATURES

- Low-cost solution for testing burning parameters of energetic materials or igniters
- Closed vessels are made of high-strength stainless steel
- Working pressure up to 3,000 bar
- 5,000 bar proof pressure tested by burning gun propellants
- The **EDA** analyzer available for proper electric ignition and signal analysis

There are two versions of TSV available:

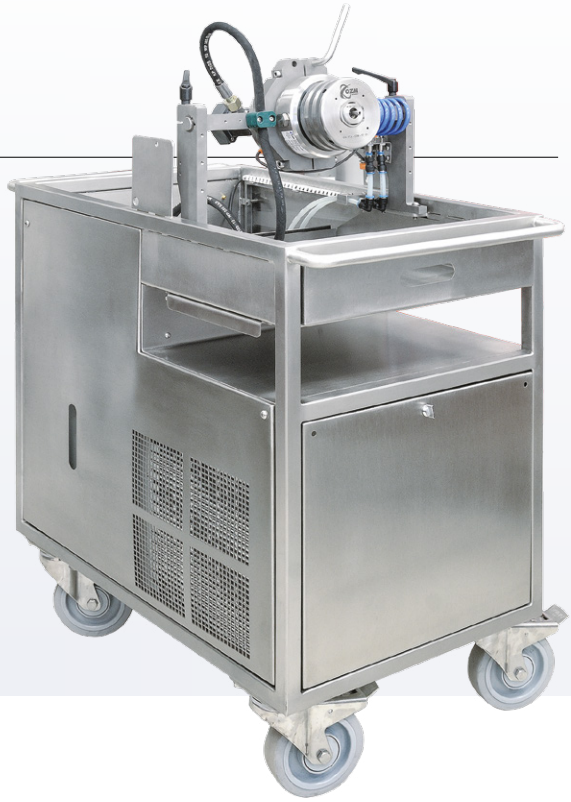
Version	Double sided open	One side open
Standard volumes [cm³]	10, 15, 20	40, 100

TSV 40 with EDA Light measurement and the control unit

TSV 15 (15 cm³)

RB SERIES

HIGH PRESSURE CLOSED VESSELS



The RB Series™ is a portable instrumentation for measurement of the burning parameters (pressure-time profile, vivacity, pressure gradient, maximum pressure, force etc.) of gun propellants in the pressure range up to 5,000 bar. The RB Series is fully professional system for ignition, measurement and evaluation, coupled with selected closed vessel.

APPLICATIONS

The **RB Series** apparatus is used for measuring the burning pressure profile of gun propellants.

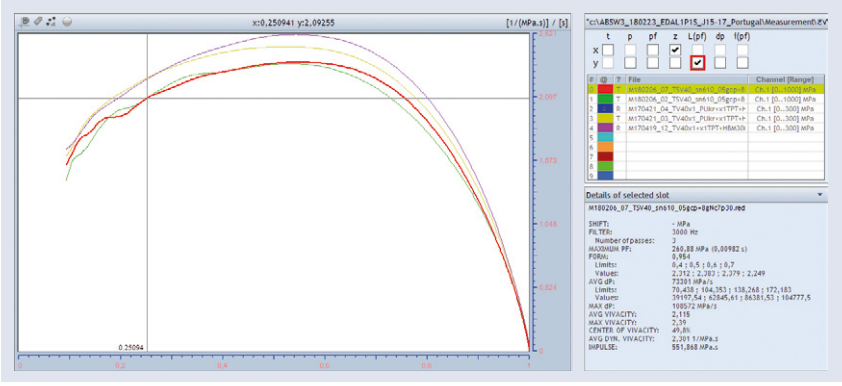
The **RB Series** are especially suitable for research, development and quality control in the manufacture and in-service surveillance of gun propellants.

ADVANTAGES & FEATURES

- Heavy-duty closed vessels made of high-strength stainless steel
- Working pressure up to 5,000 bar
- 6,000 bar proof pressure tested by burning gun propellants
- An analyzer for proper electric ignition and signal analysis
- The **ABSW**™ software for operation and evaluation of results
- Unique design of the test vessels allows for easy access for their cleaning

COMPLIANCE

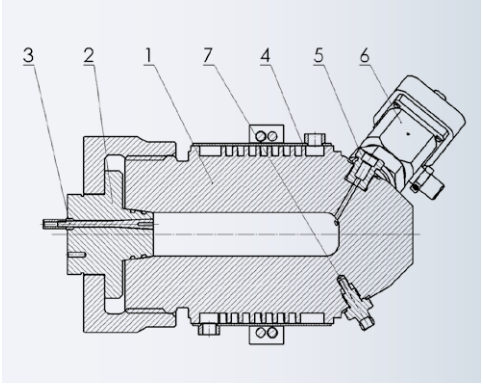
- **STANAG 4115**
- **MIL-STD-286C**



ABSW software – vivacity evaluation chart

RB 200 vessel on support stand
with Chiller unit and schematic vessel parts:

1. Pressure vessel
2. Breech nut with lid
3. Electrical ignition
4. Water cooling jacket
5. Pressure transducer adapter
6. Gas release valves
7. Temperature sensor



EDA

ELECTRO-EXPLOSIVE DEVICES ANALYZER

The EDA™ Electro-explosive Devices Analyzer is a universal measuring and control unit serving for precisely-defined ignition of samples of energetic materials or explosive devices, combined with the simultaneous high-speed measurement of dynamic pressure, temperature and emitted light.

The EDA allows for precise adjustment of ignition current value and time for generation of precise constant current, voltage or power impulse. Maximum pressure, burning time, ignition delay time, current and voltage levels, pressure gradient, pressure rise time and/or the burning rate may be recorded and evaluated.

APPLICATIONS

The **EDA** is a necessary accessory for ballistic experiments with gun and rocket propellants in closed vessels (**TSV Series** and **HPA 1500**), as well as for testing electric initiators (fuse-heads, squibs, detonators etc.) in research, development, quality control, qualification and surveillance programs.

The explosive and automotive industry, research, development and quality control laboratories around the world rely on the **EDA** for its precision and reliability.

ADVANTAGES & FEATURES

- Compact solution for both proper ignition and high-speed measurement
- Precise current source with guaranteed rise time
- Determination of bridge-wire resistance of ignition elements
- Adjustment of ignition current, voltage or power level and impulse duration
- Two different control units designed for different applications available
- Strain-gauge transducers for static and dynamic measurements or piezoelectric transducers for dynamic measurements of pressure, force, acceleration etc.
- Temperature and emitted light sensors available for incorporation
- The **ABSW**™ software for calibration, measurement, control of the pulse current source and results evaluation

There are two basic versions of **EDA** analyzer available:

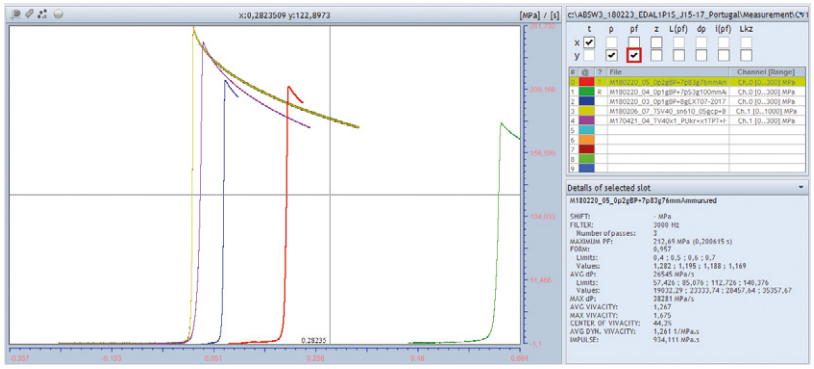
Version	EDA *)	EDA Light
Current rise time	≤ 20 µs	≤ 50 µs
Max output current and voltage	10 A / 20 V (optional 44 V)	11 A / 22 V
Measurement and recording of ignition current and voltage	YES	NO
No of optional inputs	2	4
Current flow trigger signal	YES, adjustable from recorded signal	YES, ON/OFF only
Typical applications	Testing of electric igniters and detonators with measurement of ignition voltage and current	Testing of energetic materials by measurement of burning pressure in the closed vessels

*) On request only

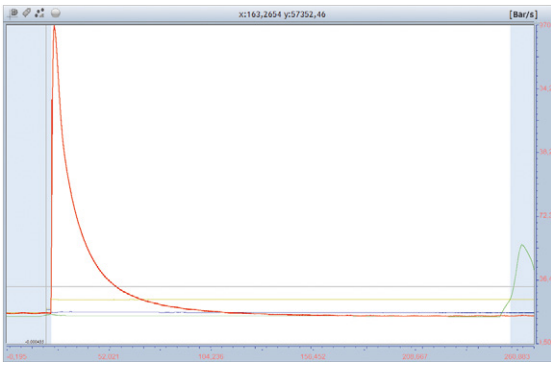
COMPACT SOLUTION FOR PROPER IGNITION AND MEASUREMENT

COMPLIANCE

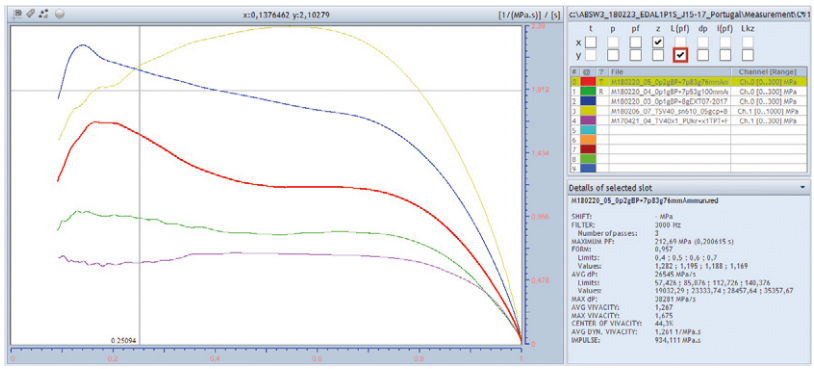
- EN 13763-16
- EN 13763-17
- EN 13763-18
- EN 13763-19
- EN 13763-20
- EN 16265
- ISO 14451-2
- SAE/USCAR 28



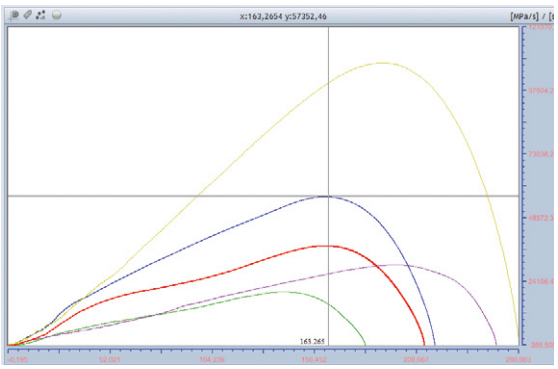
Burning pressure-time profiles of different smokeless powders in a closed vessel before evaluation



Evaluation of a delay time of an igniter – two pressure values, together with the ignition voltage and current



Evaluated dependence of Vivacity on the propellant burnt mass ratio



Evaluated dependence of the pressure gradient on pressure

STOJAN VESSEL® SV-2

FOR BURNING RATE MEASUREMENT OF SOLID ROCKET PROPELLANTS IN A CLOSED VESSEL

The SV-2 (Stojan Vessel®) is designed for the time and cost saving determination of the burning rate vs. pressure dependencies of solid rocket propellants. A single shot is sufficient for plotting burning rates in the whole pressure range.

The measurement using Stojan Vessel is primarily based on the advanced procedure for the determination of the burning rate of solid rocket propellants. In comparison with the Strand Burner, Stojan Vessel is a simple and safe instrument based on the more advanced mathematical procedure for calculation of ballistic properties taken from a single shot only. This procedure was invented and developed by Dr. Petr Stojan and the measurement using his instrument became the standard testing method for rocket propellants in the Czech Republic.

Stojan Vessel
on a movable stand

APPLICATIONS

The **SV-2** is used for research and development, for manufacturing quality control or in-service surveillance of both double-base and composite solid rocket propellants. The method can reveal with high sensitivity and reliability the following factors influencing ballistic behavior of the tested propellants:

- Influence of additives (moderators, catalysts, binders, oxidizers etc.)
- Dependence on initial temperature
- Prediction of unstable burning or explosion hazards after ageing tests

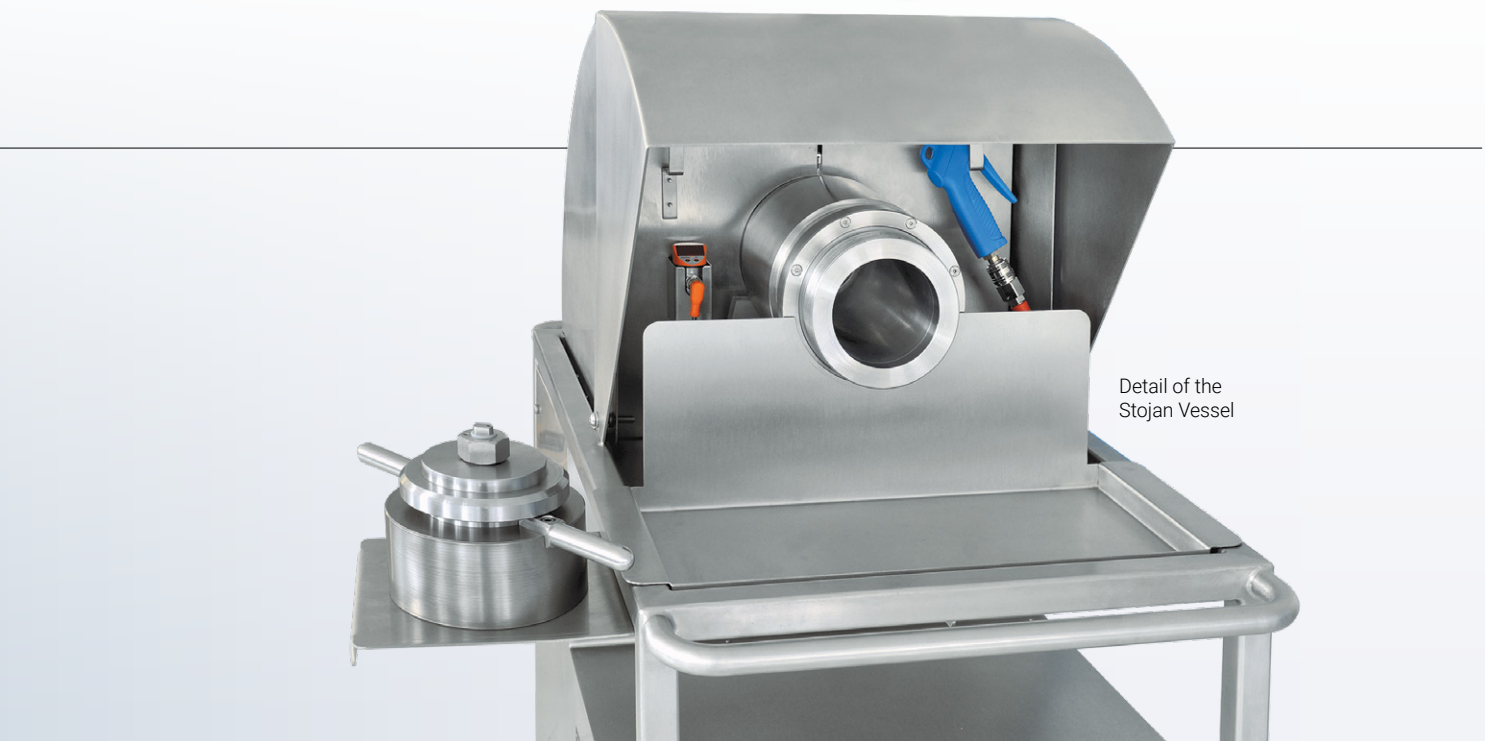
OPTIONAL ACCESSORIES

Optionally, it is possible to choose a larger volume of the SV5-PV test vessel, which is intended primarily for testing samples in a closed vessel up to pressure of 50 MPa (e.g. testing of a piece of combustible case or ignition part of a modular charges). Furthermore, it is possible to upgrade the equipment for testing in inert gas at a semi-constant pressure up to 15 MPa and in addition a sapphire window in the lid of the chamber.

OZM Research can also supply all the equipment and procedures necessary for sample preparation and conditioning of both the **SV-2** and the **LTRM** instruments (hydraulic press, pressing tools, molds for casting, cutting machines, cutting tools, temperature chambers, etc.). Laboratory sub-scale rocket motor available for validation of measurement.

Measurement and remote control unit

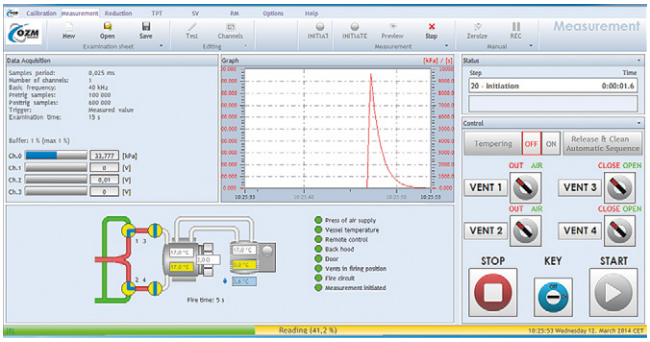
Pressing tools



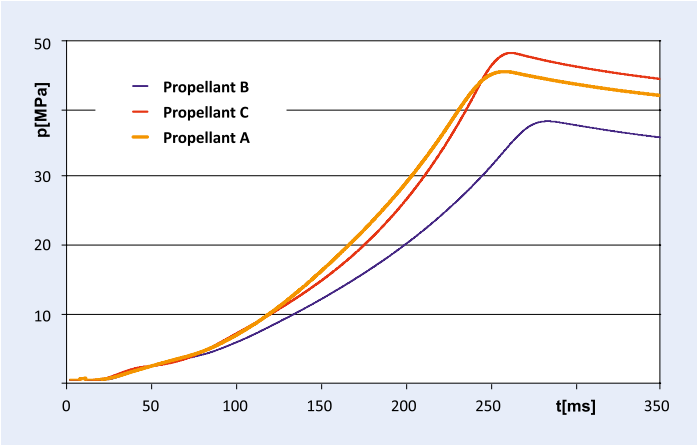
Detail of the Stojan Vessel

ADVANTAGES & FEATURES

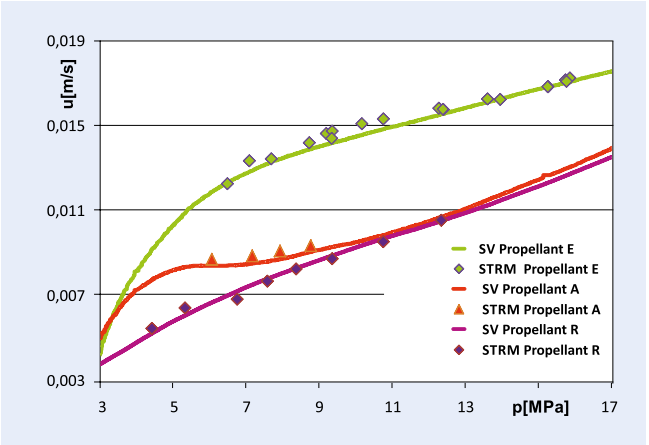
- Quick and safe operation, fully remote controlled
- Design of the stainless steel closed vessel allows for easy cleaning of composite propellants residues
- Working pressure up to 500 bar
- 750 bar proof pressure tested by burning solid propellants
- Compact mobile working trolley with in-built chiller



Measurement module with remote control section during data recording (after firing el. fuse-head)



Burning pressure (p) – time (t) dependencies measured using Stojan Vessel



Comparison of burning rate – pressure curves obtained by Stojan Vessel (line) and by Small-scale Testing Rocket Motor (points)

STOJAN STRAND BURNER SSB

APPARATUS FOR BURNING RATE MEASUREMENT OF SOLID ROCKET PROPELLANTS

The SSB™ (Stojan Strand Burner) is an improved version of Stojan Vessel® SV-2 apparatus for the determination of the burning rate of solid rocket propellants. SSB allows to conduct experiments using two different testing procedures: in constant volume or at quasi-constant pressure.

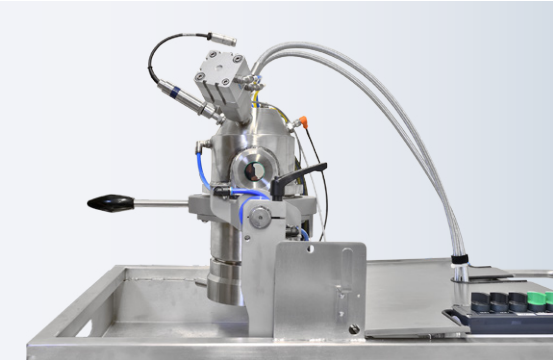
APPLICATIONS

The **SSB** is used for research and development, for manufacturing quality control or in-service surveillance of both double-base and composite solid rocket propellants. The method can reveal with high sensitivity and reliability the following factors influencing ballistic behavior of the tested propellants:

- Influence of additives (moderators, catalysts, binders, oxidizers etc.)
- Prediction of unstable burning or explosion hazards after ageing tests
- Dependence on initial temperature

ADVANTAGES & FEATURES

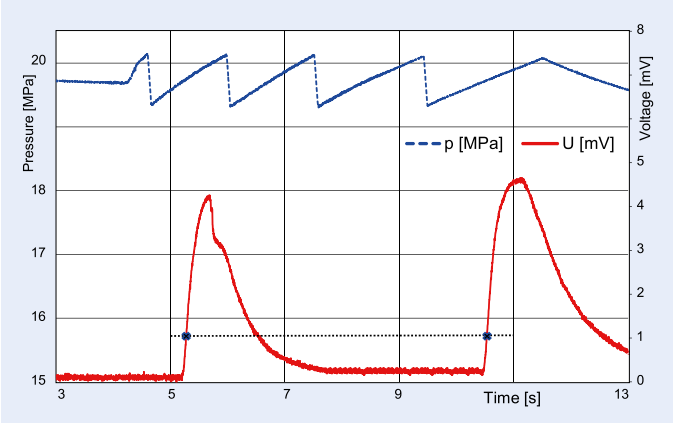
- 2 in1 instrument: Stojan Vessel **SV-2** + Strand Burner (Crawford bomb)
- Working pressure up to 300 bar (SB) or 500 bar (SV)
- 750 bar proof pressure tested by burning solid propellants
- Quick and safe operation, fully remotely controlled
- Design of the stainless steel vessel allows for easy cleaning of the solid residues
- Compact mobile working trolley with in-built chiller
- Testing vessel with two opposite windows on the side is available upon request



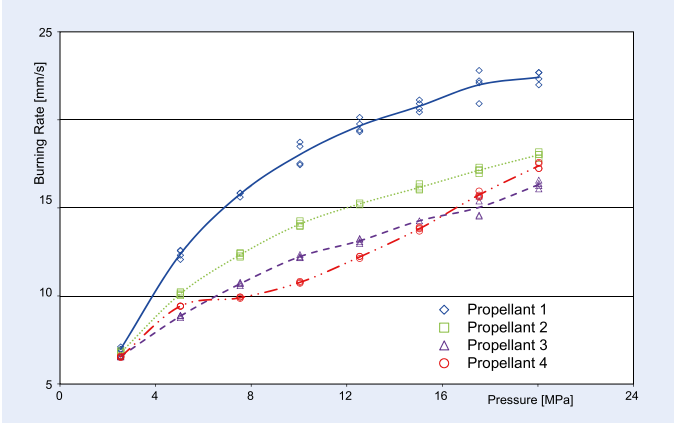
Testing vessel with two opposite windows (upon request)

COMPLIANCE

- **MILD-STD-286C**



Example of pressure oscillations (upper) and voltage signal from thermocouples (bottom) for Strand Burner mode

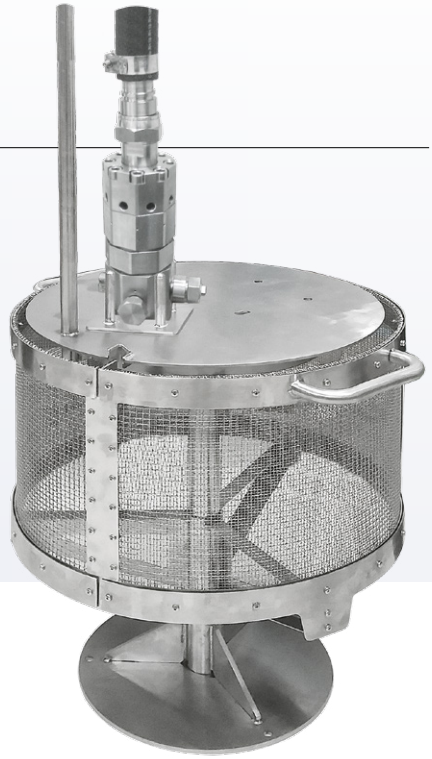


Example of burning rates measured using Strand Burner mode

LTRM

LAB-SCALE TESTING ROCKET MOTOR

The Lab-Scale Testing Rocket Motor LTRM™ is used as an auxiliary equipment to the SV-2 (Stojan Vessel®) or as a low-cost solution for the determination of burning rate of solid rocket propellants in sub-scale laboratory conditions. Pressure-time burning profiles can be measured on LTRM using EDA or EDAL high-speed analyzers.



LTRM on a test stand

APPLICATIONS

Combination of **LTRM** with Stojan Vessel is recommended especially for research and development of new compositions, catalysts and additives or for quality control of manufactured solid rocket propellants and their in-service surveillance.

Testing by **LTRM** provides more additional information to results obtained by **SV-2** or **SSB** tests (values of maximal and mean pressure, impulse of pressure, burning time, burning rate of solid rocket propellant, characteristic velocity, temperature sensitivity coefficient, etc.). These results are close to the full-scale rocket motor in a cost effective way.

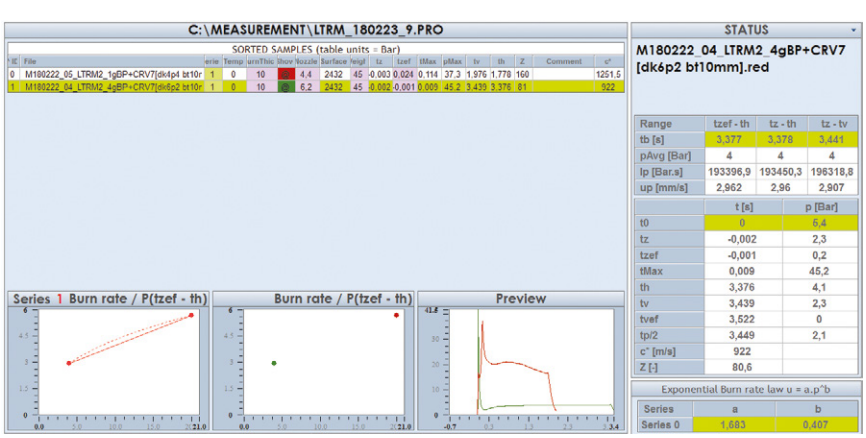
LTRM detail

ADVANTAGES & FEATURES

- Only pressure measurement - No thrust!
- Working pressure up to 500 bar, inner diameter 56 mm and length 100 mm
- High level of safety with two overpressure protections
- Simple operation
- Beneficially combined with Stojan Vessel **SV-2** or **EDA** analyzer
- Stainless steel stand with a basket for catching small burning particles
- Testing motor and the **ABSW**™ sofware for evaluation included

COMPLIANCE

- **STANAG 4672**
- **STANAG 4673**

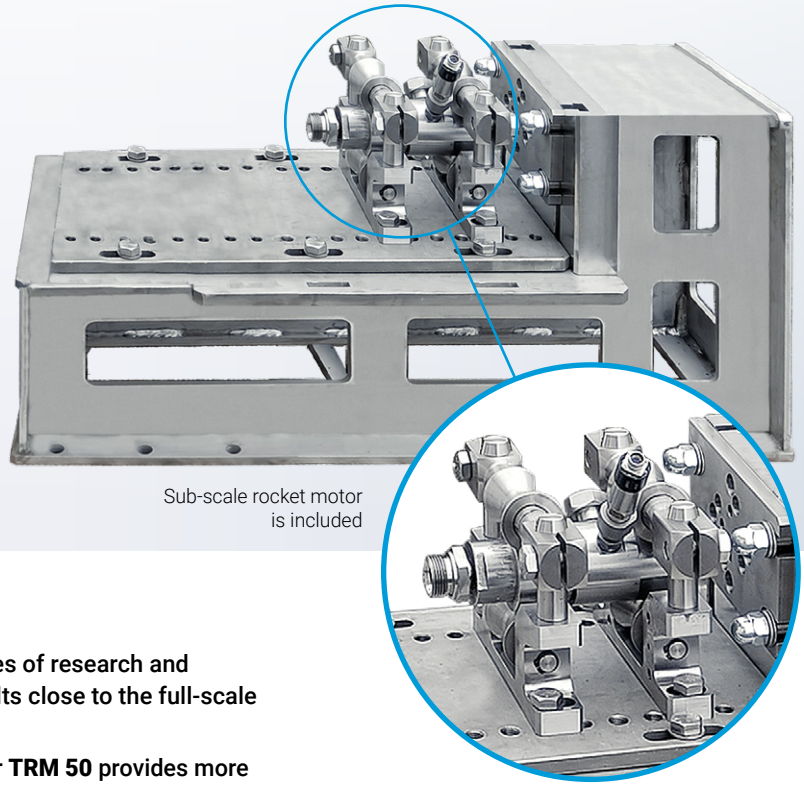


ABSW software screenshot

TRM 50

SUB-SCALE TESTING ROCKET MOTOR SYSTEM

Sub-scale testing rocket motor TRM50™ is a measurement system designed for determination of pressure and thrust profiles and evaluation of combustion parameters of solid rocket propellants.



Sub-scale rocket motor is included

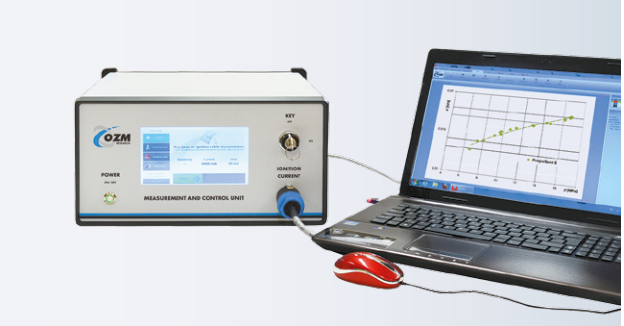
APPLICATIONS

The sub-scale testing is usually used in the final stages of research and development of the rocket propellants, providing results close to the full-scale rocket motor in a cost effective way.

Compared to **LTRM**, the sub-scale testing rocket motor **TRM 50** provides more complex results of ballistic experiments (maximum and mean pressure, pressure impulse, burning time, burning rate, specific impulse or temperature sensitivity coefficient) using variable chamber lengths and nozzle shapes.

ADVANTAGES & FEATURES

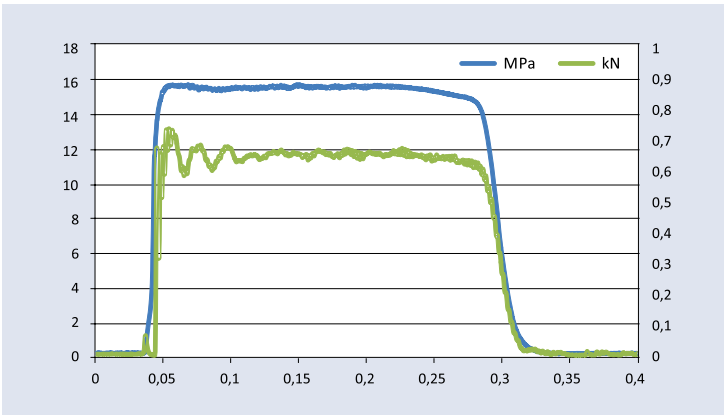
- Combined pressure and thrust measurement
- Precise measurement and control unit with electric ignition
- Working pressure up to 500 bar, inner diameter 50 mm and length from 75 mm to 500 mm
- Simple operation
- Set of testing motors and **ABSW**™ evaluation software included



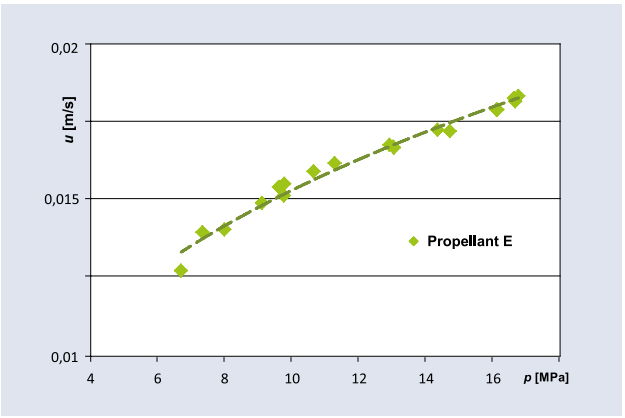
Measurement and control unit with PC

COMPLIANCE

- **STANAG 4672**
- **STANAG 4673**



Example of pressure and thrust profiles measured in the Testing Rocket Motor



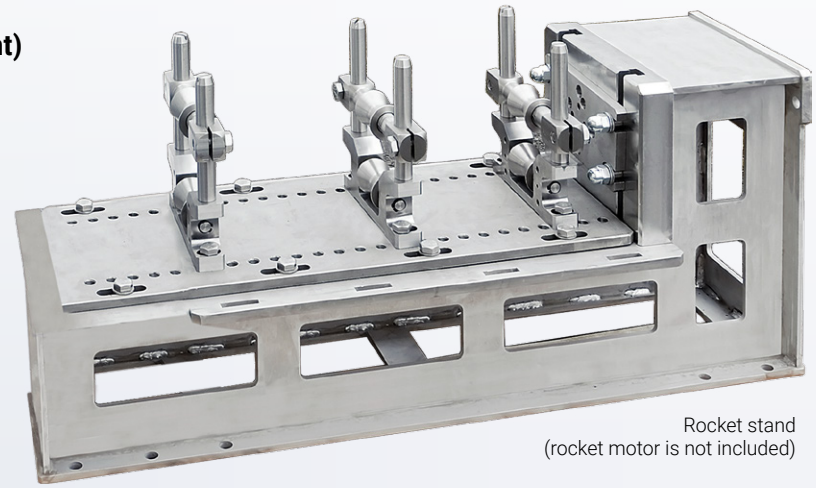
Burning rate vs. pressure dependence evaluated from the Testing Rocket Motor measurements

RMM

UNIVERSAL CUSTOMIZED SYSTEM FOR ROCKET MOTORS TESTING

The RMM™ (Rocket Motor Ballistic Measurement) is a system designed for the measurement of thrust and pressure profiles of different types of rocket motors mounted on a test stand.

The RMM is an ideal solution for the research and development of different types of customized and user-specific rocket motors, cartridge-actuated devices and propellant-actuated devices, for their quality control in manufacture and in-service surveillance.



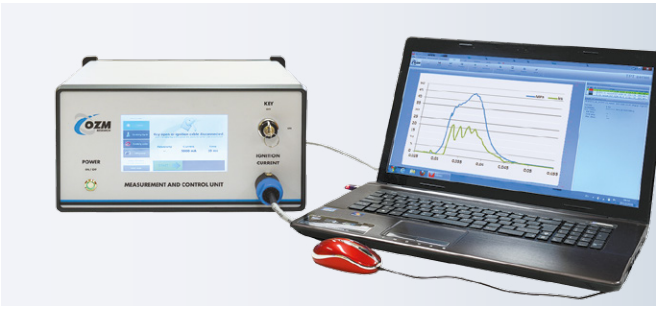
Rocket stand
(rocket motor is not included)

APPLICATIONS

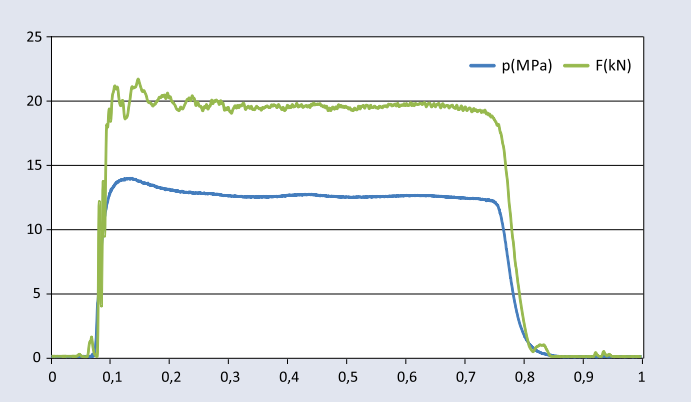
Rocket Motor Ballistic Measurement (**RMM**) is used for the measuring of pressure inside rocket motor chamber and thrust (force) of rocket motor with time during burning different types of solid propellant in rocket motors mounted on stand.

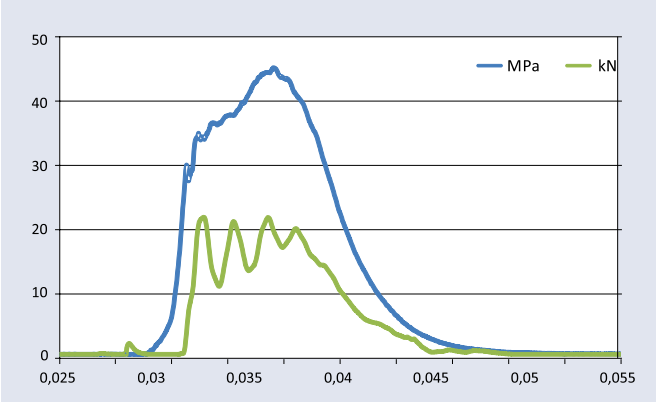
ADVANTAGES & FEATURES

- Dynamic measurement of pressure and thrust by strain-gauge transducers with long record times, combined with precisely defined electrical ignition
- Optional temperature, light or dynamic piezoelectric measurement available
- Sophisticated data acquisition and evaluation software with simple operation
- OZM Research provides necessary tailoring for fitting the customer's motors and applications to the **RMM** setup
- Rocket motor IS NOT INCLUDED



Measurement and control unit with PC





Examples of measured pressure and thrust profiles of two different rocket motors on a stand

SAFE STORAGE AND TESTING IN LABORATORIES

SAFE STORAGE OF EXPLOSIVES FROM SMALL SAMPLES TO LARGER STOCKS

Handling sensitive and/or potentially unstable explosive materials always brings inherent risks of accidental explosions. Testing primary explosives and sensitive pyrotechnics, synthesis and characterization of new explosive materials of unknown properties or handling explosive samples after long-term stability tests are the typical examples of the operations with elevated risks.

In order to minimize the risks, OZM Research delivers special equipment for safe storage, handling, performance testing and disposal of the explosive samples.

EXPLOSIVES HANDLING WORKBENCH

A workbench with adjustable height, designed for safer sampling and processing highly sensitive explosive substances and devices.

The reinforced steel working table structure and the front ballistic safety glass are protecting the head, body and legs of the operators against explosion and fragmentation effects of up to 10 g TNT eq. The table also provides the **ESD** protection necessary for safe handling the sensitive explosive materials.

STORAGE CONTAINERS

Storage containers are gas-tight explosion-resistant vessels that allow to safely store and transport up to 500 grams of highly sensitive or unstable explosive materials without any risks to the surroundings.

J-020

ADVANTAGES & FEATURES

- All explosion effects contained inside, no release of shock wave, fragments, flame or toxic gases
- Overpressure safely released through manually opened valves
- Full protection of life and property in case of accidental explosion of stored explosive samples
- Zero safety distances: they can be stored directly inside laboratories
- Portable for transport of the explosive samples outside laboratories
- Interior made of antistatic rubber for eliminating risks of friction or spark discharge
- Quick opening and closing mechanisms
- Certified for international transport of dangerous goods according to ADR/RID treaties

Product name	J-020	J-120G	J-500G
Capacity [g TNT]	20	120	500
Weight [kg]	6	40	400
Outside dimensions L × W × H [mm]	Ø 192 × 427	373 × 338 × 575	1,250 × 792 × 852
Internal space L × W × H [mm]	Ø 40 × 169	Ø 140 × 302	500 × 300 × 300

STORAGE MODULES

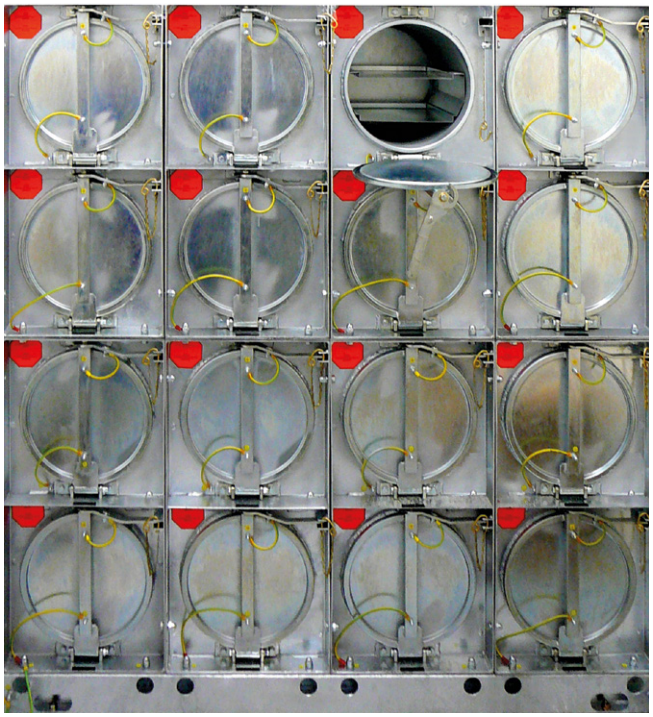
Storage modules allow to expand capacity of storage rooms for explosive samples and to safely isolate incompatible classes of explosive materials.

Storage modules provide protection against sympathetic explosion among modules, allow for common storage of otherwise incompatible classes of energetic materials and minimize the maximum explosion event to the content of a single tube of the module (max. 2.5 kg TNT).

Storage capacity	2.5 kg TNT in one tube = 5 kg TNT per module
Tube internal dimensions	Diameter × length = 300 × 500 mm
Module outside dimensions	H × W × L closed (open) = 803 × 400 × 588 (959) mm
Empty weight of the module	135 ± 5 kg
Sand filler weight for one module	100 – 110 kg
Total weight of the filled module	230 – 250 kg

ADVANTAGES & FEATURES

- Safety distances corresponding to the content of one tube of the module only (up to 2.5 kg TNT) despite total stored amount in the storage room (up to several tons)
- Minimization of safety distances / maximization of storage capacity of existing storage rooms
- Modules designed for mounting to sets with variable heights and widths
- Non-sparking and water-tight lids, antistatic rubber seals
- Grounding of all metal parts to a common potential



Modules are mounted together to walls of variable dimensions

PROTECTIVE TESTING CONTAINER

Stainless steel protective container with the free volume of about 50 liters, resistant to explosion of up to 10 g TNT.

APPLICATIONS

It is designed for safe execution of ballistic tests (small-scale rocket motors testing, closed vessel tests) with elevated risks of testing vessel rupture and for disposal of explosive samples by burning. It is equipped with explosion-proof windows, bushings for firing cables and measuring cables, ports for inert gases and the output chimney for convenient execution of the experiments.

POLLUTION ABATEMENT SYSTEM (PAS)

Autonomous system for treating off-gases from experiments in detonation chambers and ballistic vessels before their releasing to the outside air, for the environmental protection and occupational hygiene.

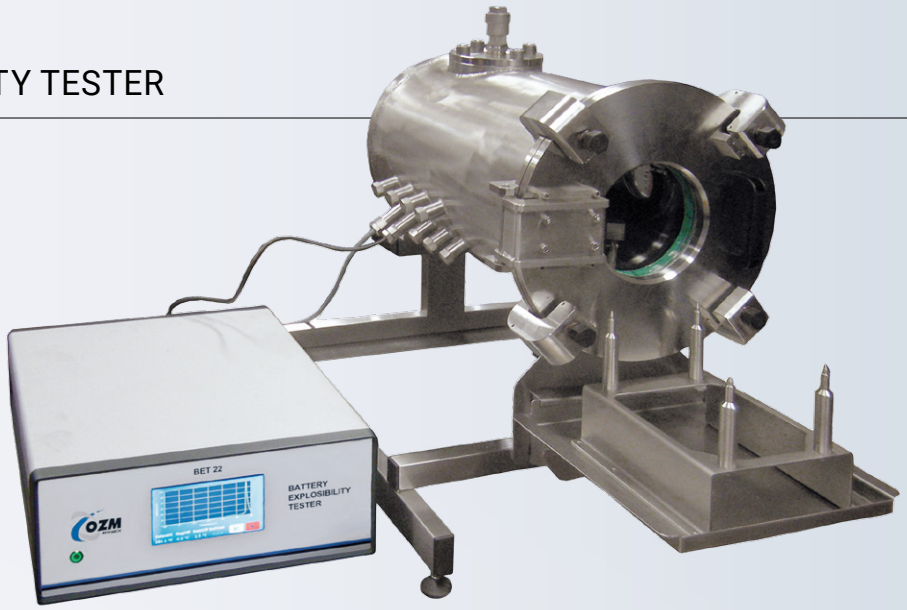
Four-step gas filtration process involving separation of coarse particles, filtration of fine particles, sorption of sub-micron particles and acid gases, adsorption of semi-volatile organic compounds and/or mercury vapors.

PAS design was proven in industrial operations at multiple installations since 2003 for serial disposal of ammunition elements with heavy metal content. Filtration effectiveness >99.9 % for heavy metals, >95 % for acid gases. Containerized version available, built-in a 20' HC shipping container.

BET 22

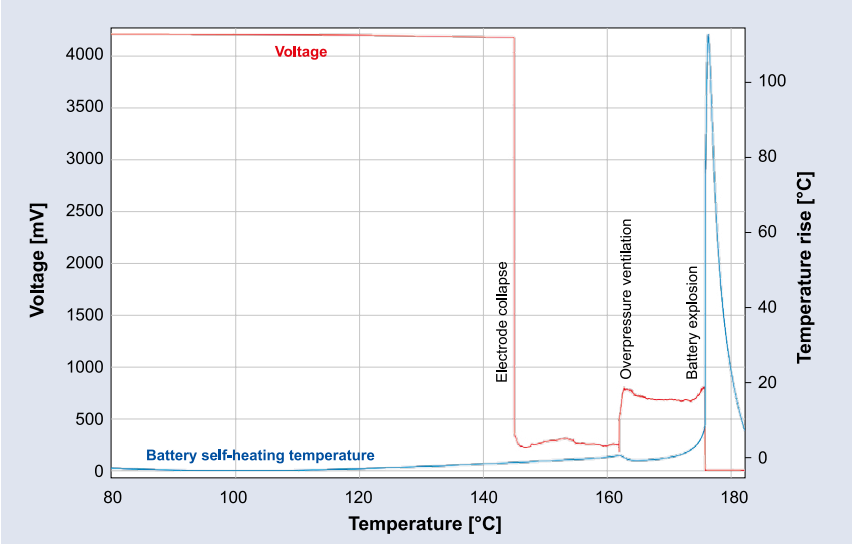
LITHIUM BATTERY EXPLOSIBILITY TESTER

The BET 22 is a unique instrument designed for safe execution of explosibility tests of lithium battery cells, with extensive characterization of their thermal stability and explosive properties. The instrument allows carrying out these experiments safely in laboratory conditions using gas-tight explosion-resistant container and extra-low voltage electrical heating block.



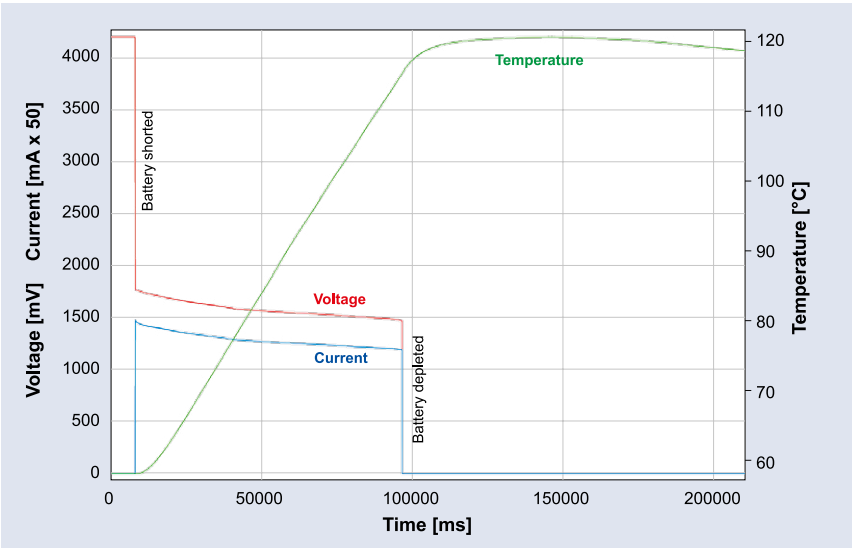
APPLICATIONS

- Comparisons of thermal stability and explosibility parameters of different battery types and chemistries
- Development of new battery compositions with higher thermal stability and reduced explosibility
- Safety qualification of battery cells for different applications
- Quality control of battery samples by thermal analysis in production and assembly
- Assessment of fire, explosion and toxicity risks for the fire prevention and extinguishing operations



Thermal analysis of a Li-ion battery cell

Interior of the container with an electrical heating block

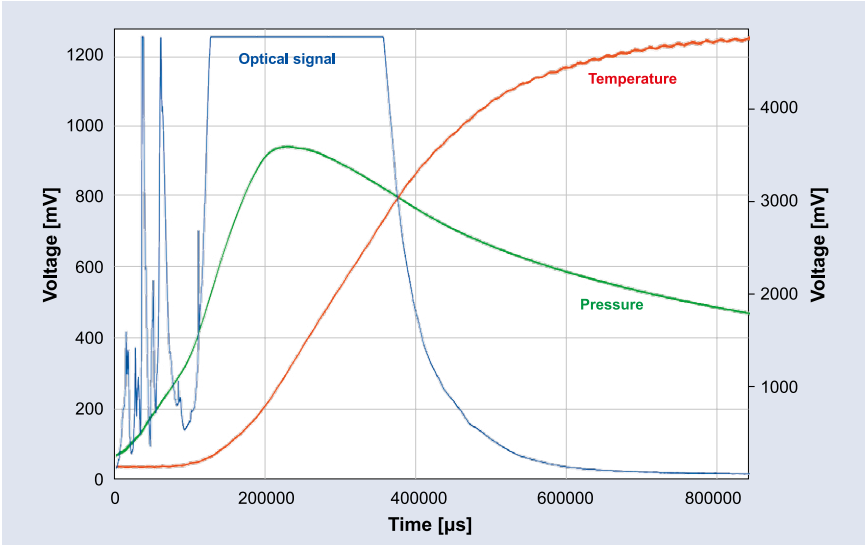


Short-circuit behavior of a Li-ion battery cell at 57 °C

Video sequence of a Li-ion battery explosion

ADVANTAGES & FEATURES

- Safe examination of the battery cell thermal analysis, overcharging and short-circuit behavior at different temperatures, states-of-charge and gas atmospheres, with measurement of explosion parameters in a single instrument.
- Thermal analysis of the whole battery cell with constant heating rate until explosion precisely determines temperatures of the electrode separator failure, overpressure ventilation and thermal explosion, all related to the battery cell design, thermal safety and production quality.
- Characterization of the short-circuited or overcharged battery cell self-heating at elevated temperatures leading to the thermal runaway reaction to explosion.
- Multi-channel high-speed simultaneous measurement of temperatures, pressure, heat flow, optical signal, voltage and current precisely characterizes all aspects of the battery cell behavior in accidental scenarios.
- Large observation windows allow to record video sequences of the battery explosions and to overlay them with the simultaneously measured experimental data.
- The container design allows sampling of the reaction gases in all stages of the battery thermal decomposition and carrying out the experiments in defined gas atmospheres. Solid residues can be sampled as well.
- **BET 22** can simulate more realistic accident scenarios with higher temperatures than prescribed in the related international standards.



Thermal explosion reaction of a Li-ion battery cell

COMPLIANCE

BET 22 complies with and goes far beyond requirements for safety tests according to these standards:

- **UN Recommendation on the Transport of Dangerous Goods**, Manual of Tests and Criteria (2015), chapter 38.3, Test T.5 (External short circuit) and Test T.7 (Overcharge)
- **EN IEC 62133-2**, Test 7.3.1 (External short circuit), Test 7.3.4 (Thermal abuse) and Test 7.3.6 (Overcharge)
- **EN IEC 62660-2** ed.2, Test 6.3.1 (High temperature endurance) and Test 6.4.2 (Overcharge)
- **EN IEC 62660-3**, Test 6.3.1 (High temperature endurance) and Test 6.4.2 (Overcharge)

INSTRUMENTS FOR FLAMMABLE MATERIALS & SAFETY ENGINEERING

OZM RESEARCH

Testing Instruments

for Hazardous Flammable Materials

www.ozm.cz

PRODUCT CATALOGUE

CA 12L

EXPLOSION CHAMBER FOR GASES AND VAPORS

Explosion chamber is used for measurement of basic explosion characteristics of flammable gases and vapors at standard and also elevated initial temperatures (up to 200 °C) and initial pressures (up to 12 bar). These characteristics are maximum explosion pressure, maximum rate of pressure rise, lower and upper explosibility limits and limiting oxygen concentration.

CA 20L and CA 20L CRYO

EXPLOSION CHAMBER FOR GASES AND DUSTS

Explosion chamber is used for measurement of explosion characteristics of flammable dusts, gases, vapors and hybrid mixtures, such as maximum explosion pressure, maximum rate of pressure rise, lower and upper explosibility limits and limiting oxygen concentration. For gas testing, the chamber can be equipped with a cryo extension allowing experiments at temperatures starting from -70 °C.

MIT 1000

MINIMUM IGNITION TEMPERATURE TESTER

The **MIT 1000**™ (Minimum Ignition Temperature Tester) is used for determination of minimum temperature of a hot surface which leads to thermal degradation or ignition of dispersed dust particles.

LIT 400

DUST LAYER IGNITION TEMPERATURE TESTER

The **LIT 400**™ (Dust Layer Ignition Temperature Tester) is used for determination of minimum temperature of a hot surface leading to thermal degradation or ignition of dust layers of a defined thickness.

RSIT 400

RELATIVE SELF-IGNITION TEMPERATURE FOR SOLIDS

The **RSIT 400**™ (Relative Self-ignition Temperature for Solids) device is used to measure self-ignition temperature of solid substances – the lowest possible ambient temperature at which a substance will spontaneously self-ignite.

MIE-D 1.2

MINIMUM IGNITION ENERGY OF DUST DISPERSIONS

The **MIE-D 1.2**™ is an apparatus for measurement of minimum ignition energy of dust dispersions according to EN 13821. The minimum ignition energy (MIE) of a combustible substance is the lowest value of the electrical energy stored in a capacitor, which upon discharge just suffices to ignite the most readily ignitable fuel/air mixture of the tested material (fuel) at the atmospheric pressure and room temperature.

AIT 551

AUTOIGNITION TEMPERATURE OF LIQUIDS APPARATUS

Autoignition temperature is the lowest temperature at atmospheric pressure at which a substance will burst into flame in the absence of an external source of ignition (spark or flame). The **AIT 551**™ (Autoignition Temperature Tester) is used for the determination of the autoignition temperature of liquid samples using visual observation and sample temperature measurement.

TST 75

THERMAL STABILITY TEST AT 75 °C

Thermal stability test using **TST 75**™ characterizes response of energetic materials to thermal shock. This test detects exothermal decomposition of a sample heated in an oven at a constant temperature of 75 °C.

FRTA I

FOR DETERMINATION OF CONCENTRATION LIMITS OF FLAMMABILITY

The **FRTA I**™ (Instrument for Concentration Limits of Flammability Determination) is designed to determine both the Lower Flammability Limit (LFL) and the Upper Flammability Limit (UFL) of various flammable gases or volatile liquids. The **FRTA I** applies high voltage electrical ignition and visual observations of flame propagation.

SHT 150

SELF-HEATING SUBSTANCE APPARATUS

The **SHT 150**™ (Self Heating Substances Tester) is used for determination of a substance's self-heating characteristics. The **SHT 150** analyses exothermal decomposition of a sample being directly exposed to hot air. Substances with self-heating potential can self-ignite even at moderate temperatures when stored in large amounts over long periods of time.

TRAINING & EDUCATION

TRAINING AND EDUCATION CENTRE

Due to the extensive safety risks connected with handling with explosives, responsible personnel should have a profound knowledge of the properties and safety characteristics of these dangerous materials. Therefore, we offer unique training courses combining theoretical lectures with practical exercises.

These courses are conducted by qualified experts and specialists from academia and explosives industry. The content of each course is tailored in close cooperation with customers to meet all their needs and expectations. We offer all educational levels of the training, both basic and advanced.

OZM TRAINING CENTER CZECH REPUBLIC

OVERVIEW

We offer comprehensive training courses combining theoretical lectures with practical laboratory exercises. This idea to combine both forms of education allows us to provide a world-class unique experience to our customers.

Our training courses are conducted by qualified experts and specialists from explosives industry and by university professors, who possess extensive experience and long-term research praxis in the field of theory and technology of explosives.

The courses are designed especially for researchers and technologists with only general knowledge of manufacture and application of energetic materials. Young Ph.D. students and scientists at the beginning of their professional career can also take part in them to enhance their expertise and support their further professional growth.

The basic courses will give the participants a comprehensive overview of the field of chemistry and production technology of the whole range of industrially manufactured explosives, theory of explosion and detonation, explosion effects, characterization of energetic materials and safety and risk analysis. We also offer advanced training courses for specific subjects, e.g. advanced interior ballistics, stability of explosives, etc. The list of our basic and advanced courses is given below.

5 DAYS / 40 HOURS

Our training courses are scheduled in five-day blocks (40 hours) and detailed content of each block is tailored in close cooperation with our customers. The philosophy of our courses is to prepare remarkable educational package for the customer's employees, therefore only small group of attendees (4–6) is involved in each block. This ensures the individual approach to each course participant.

THEORY & PRAXIS

Approximately half of the course duration includes a theoretical training and then, in the second half of the course, the participants can personally apply obtained theoretical knowledge during experimental laboratory training. These practical exercises give the participants a great opportunity to quickly improve their knowledge and practical skills to ensure a better understanding of all aspects of handling, processing and applications of explosive materials.

LIST OF TRAINING COURSES

BASIC TRAINING COURSES

1	**Chemistry of Explosives** The Chemistry of Explosive Compounds ▪ Secondary Explosives: Basic Properties ▪ Primary Explosives: Basic Properties ▪ New Energetic Materials ▪ Laboratory Training (Synthesis of Primary Explosives, Basic Analysis and Testing of the Selected Explosives)	5 days
2a	**Propellants – Theory and Technology of Gun Propellants**	5 days
2b	**Propellants – Technology of Ball Powders**	5 days
3a	**Propellants – Technology of Cast Double-Base Propellants**	5 days
3b	**Propellants – Theory and Technology of Pressed Solid Rocket Propellants** Ballistic Cycle ▪ Chemistry of Propellants ▪ Principles of Production ▪ Thermochemistry ▪ Pyrostatics and Basic Interior Ballistics ▪ Chemical Stability of Propellants ▪ Propellant Examination and Testing ▪ Future Trends in R&D of Propellants ▪ Laboratory Training (Calculation of Propellant Thermodynamical Properties, Preparation of Propellant Samples, Dimension Measurements, Density and Bulk Density, Closed Vessel Examination and Burning Rate Examination, Evaluation of Results)	5 days
4	**Initiation Technology and Associated Energetic Materials** Introduction and Theory of Initiation in Practice ▪ Auxiliary Initiators Characteristics and Application ▪ Basic Initiators (Non-Electric) ▪ Electroexplosive Devices: Main Types ▪ Laboratory Training (Demonstration of Different Initiators, Non-Electric Initiation and Detonators)	5 days

5a	**Theory of Explosion** Basic Principles ▪ Energetics of Explosives ▪ Calculations of Thermochemical Properties of High Explosives ▪ Detonation: General Observation and Real Effects in Explosives ▪ Laboratory Training (Measurements of Detonation Velocity, Measurement of Detonation Front Curvature, OPTIMEX)	5 days
5b	**Explosion Effects** Shock Waves and Detonations ▪ Explosions in Air ▪ Underwater Explosions ▪ Fundamentals of Shaped Charges ▪ Laboratory Training (Measurement of Incident Blast Wave and Determination of TNT Equivalency, Gurney Velocity Measurement, EXPLO5 Calculation)	5 days
6	**Technology of Explosives** Categories of Explosives by Chemical Types ▪ Nitro Compounds ▪ Nitric Esters ▪ Nitramines ▪ Primary Explosives ▪ Multicomponent Explosives ▪ Technology of Manufacture of Selected Explosives and Explosive Charges for both Industrial and Military Applications ▪ Laboratory Training (Preparation of Selected Types of Explosive Charges)	5 days
7	**Testing of Energetic Materials** Testing Standards and Procedures ▪ Sensitivity ▪ Characterization of Detonation Properties ▪ Stability ▪ Laboratory Training (Impact, Friction and Spark Sensitivity, Thermal Analysis, Stability and Reactivity Tests, Bomb Calorimetry, etc.)	5 days
8	**Testing of Gun Propellants and Rocket Propellants** Ballistic Cycle ▪ Chemistry of Propellants ▪ Principles of Production ▪ Pyrostatics and Basic Interior Ballistics ▪ Chemical Stability of Propellants ▪ Propellant Examination and Testing ▪ Future Trends in R&D of Gun Propellants and Rocket Propellants ▪ Laboratory Training (Dimension Measurements, Density, Bulk Density, Calorimetry, Burning Rate and Closed Vessel Examination, Evaluation of Results)	5 days
9	**Characterization of Hazard Properties of Flammable Materials. Gas, Vapor, Dust and Hybrid Mixtures** Explosions in Process Industry ▪ Introduction into Gas and Dust Explosions ▪ Influence of Gas/Vapor Cloud and Dust Cloud Properties ▪ Hybrid Mixtures ▪ Methods for Measurement of Explosion Parameters ▪ Methods for Measurement of Gas Clouds, Flammable Liquid and Dust Cloud Properties ▪ Laboratory Training (Testing of Hazardous Properties of Flammable Materials, Ignition Temperature, Minimal Explosive Energy and Concentrations, etc.)	5 days
10	**Theory of Explosive Processing of Metallic and Non-Metallic Materials** Explosive Welding ▪ Explosive Depth Hardening ▪ Explosive Compaction of Powder Materials ▪ Explosive Forming ▪ Other Application of Explosive Processing ▪ Laboratory Training (Demonstration of Explosive Welding and Explosive Hardening, Quality Control Testing)	5 days
11	**Safety and Risk Analysis in Explosives Industry** Safety in Explosives Laboratories and Industry ▪ Risk Analysis ▪ Standards and Regulations for the Construction and Operation of Explosives Industry ▪ Recommendations and Requirements for Workers	5 days
12	**Mining Works and Destruction** Blasting Techniques ▪ Industrial Explosives ▪ Design of Charges ▪ Basic Principles of Mining Works ▪ Basic Knowledge of Destruction ▪ Safety Rules ▪ Laboratory Training (Quarry visit, Practice with Chief Blaster – Handling Explosives into Boreholes, Drilling Works – visit, Blasting in a quarry, Analysis of the Blast, Grains of Rock and Visual Inspection)	5 days

ADVANCED TRAINING COURSES

We also offer several specialized advanced training courses for experts from explosives industry, military or academia, focused on selected aspects of energetic materials R&D, production and applications. Detailed content and duration of our advanced courses will be fully tailored according to requirements of each customer to meet all their needs and expectations.

OZM TRAINING CENTER CZECH REPUBLIC

- **Advanced Chemistry of High-Energy Materials**
- **Advanced Optical Measurement of Explosion Parameters**
- **Advanced Stability Testing of Explosives**
- **Analysis of Energetic Materials**
- **Applied Interior Ballistics for Practice**
- **Detonation Physics**
- **Hazard Assessment in Explosives Industry**
- **Mechanical Properties of Propellants**

Other topics upon request.

INTERNATIONAL SALES REPRESENTATIVES

ARGENTINA

Talleres Guillermo Bleif S.R.L.
1427 Buenos Aires, ARGENTINA
Phone: +54 11 48542742
E-mail: g.bleif@bleif.com.ar

CHINA

Idea Science Technology Corp.
Beijing, P. R. CHINA
Phone: +86 10 84775602
Fax: +86 10 84775603
E-mail: info@ideascience-group.com
www.ideascience-group.com

EGYPT

Engineering and Technology – MISR
Cairo, EGYPT
Phone: +20 122 714 6603
E-mail: m.ismail@engtech-misr.com

GERMANY, AUSTRIA, SWITZERLAND

Dr. Müller Instruments
Oberursel, GERMANY
Phone: +49 6172 380 3727
Fax: +49 6172 177 0774
E-mail: info@mueller-instruments.de
www.Mueller-Instruments.de

INDIA

Venture Technologies
Bangalore, INDIA
Phone: 91 80 4400 4111, 41715022
Fax: +91 80 4400 4104
E-mail: info@venturetechnologies.net
www.venturetechnologies.net

INDONESIA

PT. Radin Nusa Digna
Surabaya, INDONESIA
Contact: Widyanto Budihardjo
Phone: +62 31 732 9088
Fax: +62 31 732 5588
E-mail: radinnusa@yahoo.com
www.radinnusa.com

MALAYSIA

SII Malaysia
Subang Jaya, MALAYSIA
Phone: +60 3 5633 1432
Fax: +60 3 5633 0811
E-mail: steven.siimalaysia@gmail.com

PAKISTAN

Zema Corporation
Office # 5, 3rd Floor,
Ascon Heights, Plaza 37,
Phase 4, Civic Center, Bahria Town,
Islamabad 46220, PAKISTAN
Phone: +92 (0) 300 522 1637,
+92 (0) 300 929 6627
E-mail: zemacorporation@gmail.com

SERBIA, MONTENEGRO, BOSNIA & HERZEGOVINA

Lab Systems Support
Belgrade, SERBIA
Phone/Fax: +381 112 893 182
Mobile: +381 63 554 742,
+381 641 302 234
E-mail: lss@labsystemssupport.co.rs
www.labsystemssupport.co.rs

SOUTH KOREA

Baroin co., Ltd.
#2-320, 160, Daehwa-ro, Daedeok-gu,
Daejeon 306-754, KOREA
Phone: +82 70 4010 7476
Mobile: +82 10 2565 0526
Fax: +82 42 336 7467
E-mail: hong@baroin.co

USA

Explosives Examiners LLC
3714 Crescent Drive
Pearland, TX 77584, USA
Phone: 01-281-692-0178
E-mail: explosivesexaminers@gmail.com

VIETNAM, CAMBODIA, LAOS

Hienquang Co.
Hanoi, VIETNAM
Phone: +84 4 761 77 53
Mobile: +84 913 537 940
Fax: +84 4 761 76 91
E-mail: hienquang@fpt.vn

CONTACT US

OZM Research s.r.o.
Bliznovice 32, 538 62 Hrochuv Tynec
CZECH REPUBLIC / European Union
Phone: +420 469 692 341
WhatsApp: +420 778 456 409
Fax: +420 469 692 882
E-mail: ozm@ozm.cz
www.ozm.cz

Proud sponsor of:

- International Seminar New Trends in Research of Energetic Materials • www.ntrem.com
- International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions • ishpmie2022.ptb.de/home
- International Seminar on Fire and Explosion Hazards • isfeh9.org